



Towards regional innovation systems in Norway?

An explorative empirical analysis

Sverre J. Herstad
Tore Sandven

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Preface

This report presents the findings of an analysis of Regional innovation systems (RIS) in Norway. The analysis was undertaken as part of the research project 'Exploring the role of the VRI program in regional innovation system formation and new path development', funded by the Research Council of Norway through the VRI program and coordinated by Professor Bjørn Asheim of University of Stavanger. Tore Sandven of NIFU prepared and processed the raw data. All interpretations and any mistakes made in the subsequent analysis and presentation of this data is the sole responsibility of the first author.

This analysis uses Community Innovation Survey (CIS) data supplemented by data from the Linked Employer-Employee register (LEED) to map the evolution of regional innovation systems in Norway. The objective is explorative and empirical, in the sense that emphasis is put on developing indicators that reflect contemporary RIS theory and Norwegian innovation policy practices more so than discussing in detail the substantive implications of results.

Chapter 1 summarizes the theoretical background and policy context of the project, and proceeds to describe the data and methodology applied. Chapter 2 presents and discusses aggregate findings for Norway and summarizes the results for each of the 15 VRI regions that are presented in alphabetical order in Chapter 3 – Chapter 17.

Oslo, 03.03.2017

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Summary

It is widely recognised that regional dynamics and collaboration patterns are important for innovation activities, and vice versa that well-functioning regional innovation systems are crucial for regional development. A number of programs and instruments have therefore been established to foster innovation in a regional context.

Among these, the “Programme for Regional R&D and Innovation (VRI)” is the Norwegian Research Council’s main support mechanism for research and innovation in Norwegian regions. The primary goal of the VRI-program is

to encourage innovation, knowledge development, and added value through regional cooperation and a strengthened research and development effort within and for the regions¹

Reflecting this main objective of the VRI program, this report analyses how ‘regional innovation system’ (RIS) configurations have evolved in the 15 Norwegian target regions during the period 2004-2012. For this purpose, it develops and implements a novel approach to the use of CIS data for analyses of innovation dynamics at the regional level. Building on recent theoretical developments in the RIS tradition, it makes a clear distinction between the micro-foundations for RIS construction that is employment in learning organizations, and the local collaboration networks that define a working RIS and distinguishes it from related network configurations such as regionalized national innovation systems.

During the period considered, the micro-foundations for RIS construction in Norway weakened, as the proportion of employment occurring in innovation-active firms declined. From this follows that a fundamental challenge faced by Norwegian innovation policy is the need mobilize firms into engagement in development work. The proportion of innovation-active employment that occurred in firms with local industrial collaboration or research system collaboration also declined. At the same time, many Norwegian regions strengthened their linkages to non-local, domestic research system institutions.

Thus, whereas the VRI program has sought to mobilize firms into development work and collaboration with local research institutions, industry has responded by reducing its overall commitment to development work, and by strengthening linkages to national research institutions and international industrial networks. Notably, this trend is evident also in regions that at the beginning of the period exhibited strong indications of emerging RIS (e.g. Møre & Romsdal). To an extent that cannot be directly determined in this report, this may well reflect how dominant national innovation funding

¹ Cited from RCN’s program web-page http://www.forskningsradet.no/prognett-vri/Home_page/1224529235237

schemes such as skatteFUNN (the Norwegian tax deduction scheme) and BiA (the user-driven innovation arena administered by RCN) work towards centralisation and concentration of R&D efforts.

One important exception is the VRI region of Agder, where innovation activity was strengthened during the period and more of this activity was conducted in collaboration with local research system institutions. However, while the region emerges from the statistics as a relatively clear example of successful RIS construction, the strong impetuses for innovation it has received from the Oil & Gas industry and the associated concentration of regional innovation in technology supplier industries is reason for concern.

Background analysis of mobility flows in the Norwegian economy during the 2002-2012 period find Oil & Gas and technology-intensive manufacturing industries to be densely skill-related with each other, and with ICTs and Technical & Scientific Services. While this means that industries are benefitting from cross-fertilization through the labour market irrespective of collaborative ties, collaboration networks are dominated by manufacturing and the offshore Oil & Gas extraction industry.

The ICT sector, by contrast, which is one of the top-three contributors of innovation-active employment in the Norwegian economy, emerges as detached, and increasingly so, from the collaboration networks that define various territorial innovation system configurations (regional innovation system, regionalized national system, national innovation system). This raises the question of whether the Norwegian national innovation system, and the different regional configurations that have evolved within it, is characterized by a 'systemic lock-in' to the current Oil & Gas dominated development path that is comprised of densely skill-related manufacturing and services industries serving as technology suppliers to offshore operators and provided with strong support for this from national stronghold research institutions. Combined with the strong forces of centralisation that are arguably built into the dominant public innovation funding schemes, this may not leave much room for diverse regional innovation systems to emerge and consolidate.

1 Background

The Regional Innovation Systems (RIS) approach has been developed in close interaction with policy-making and used widely as a framework for the design, implementation and evaluation of innovation-based regional policies in a variety of countries and regions (Coenen, Asheim, Bugge, & Herstad, 2016). The main rationale for the approach is that innovation-based regional development can be fostered through active policy intervention seeking to speed up the rate of knowledge diffusion between firms and industrial sectors, and between the research system and the industrial base.

Reflecting this, RIS can be defined in a narrow and in a broad way (B.T Asheim & Gertler, 2005). The broad definition takes into account the wider system of organizations and institutions supporting learning and innovation in a region, and emphasizes the importance of knowledge development and diffusion within the domain of industry itself. The narrow definition understands RIS as constituted of two sub-systems, the knowledge exploration and diffusion sub-system (that is, universities, regional colleges, R&D institutions, technology transfer organizations) and the knowledge exploitation sub-system (that is, firms in regional clusters) and the systemic interaction between them. Accordingly, the latter definition emphasizes to a larger extent the role of research institutions as driver of innovation-based development and growth.

The aim of the VRI program is to build regional innovation systems through supporting collaboration at the regional level. One of the unique aspects of VRI as an innovation policy program, viewed internationally, is the ambition of combining these two types of RIS to form a broad based regional innovation policy. This innovative design emerged from the combining of elements of several previous regional policy initiatives, including Enterprise Development 2000, Value Creation 2010, the Industry-College Collaboration initiative and Competence Brokering scheme (Jakobsen et al., 2012).

The (initial) focus of the program on the broad definition of RIS was inherited from ED 2000 and VC 2010, of which both referred to regional development coalitions or learning regions (Asheim, 2012)). This perspective is reflected in the VRI program through the establishment of the 15 regional collaborative projects. The broad approach was originally based on an experience-based mode of innovation that was later termed the Doing, Using, Interacting (DUI) mode (Lorenz and Lundvall, 2006). It has learning work organizations as its micro foundation (Asheim, 2012) and emphasizes inter-firm collaboration for knowledge diffusion and interactive learning.

The objective of VRI then shifted towards promotion of a more R&D based mode of innovation, the so called Science, Technology, Innovation, (STI) mode (Jensen, Johnson, Lorenz, & Lundvall, 2007), by linking regional business and industry to universities, university colleges and research institutions, added the goal of promoting narrowly defined RIS. In this way, it came to reflect organizational research emphasizing the importance of 'ambidexterity' where knowledge exploration and exploitation

is combined (Levinthal & March, 1993) and anticipated the findings of later theoretical and empirical research on the importance of combining different types and sources of knowledge through combinations of DUI-based and STI-based efforts (Ebersberger & Herstad, 2011; Jensen et al., 2007; Laursen & Salter, 2006). Consequently, when addressing the question of RIS evolution, it is important to consider the *interplay* between STI and DUI-based modes of innovation against the background of evolving micro-foundations for RIS.

1.1 Types of regional innovation systems

Traditionally, a distinction is made between three different types of RIS (B.T Asheim & Isaksen, 2002). Reflecting the broad definition, the first type has been denoted as '**territorially embedded regional innovation networks**' and consists of firms that base their innovation activity mainly on localised learning processes stimulated by geographical, social and cultural proximity without much interactions with science institutions. Reflecting a stricter definition, the second is '**networked regional innovation systems**'. Compared to the former, these systems have a more planned character through the strengthening of the regional institutional infrastructure, and local science institutions work closely with industrial firms. It has been regarded as the ideal-typical RIS in that it has the potential for combining science-based (analytical, STI-based) and experience-based (synthetic, symbolic, DUI-based) knowledge and thus for reducing the risk lock-in to diminishing return paths that is high in territorially embedded regional networks. The strong embeddedness of actors and institutions in specific regional contexts delineate this model from the **regionalized national innovation system**, where innovation foremost takes place in interaction with firms or institutions located elsewhere and the linkages that form on a project-to-project basis are more based on the linear model of innovation. Thus, compared to the emphasis of the two former on endogenous development, this model represents more of an exogenous development model (ibid).

1.2 RIS and contemporary issues of regional development

As a theoretical backdrop, it is necessary to locate the RIS approach in the contemporary debate on regional development. This is because current issues, concepts and theories may at first sight appear to challenge the rationale behind the RIS approach, i.e. the rationale for building regional collaboration networks involving different industries and research institutions. Below it is demonstrated how three issues that are at the core of the contemporary regional development debate upon closer consideration substantiates rather than challenge the relevance of the RIS approach.

First, work within the fast-growing field of evolutionary economic geography (R Boschma, Eriksson, & Lindgren, 2009; Frenken, Oort, & Verburg, 2007) has convincingly argued that knowledge & skills generated as externalities of current industrial configurations contribute to channelling territorial development in certain directions, at the expense of others. Illustrating the strong path-dependencies at play, empirical research in this tradition has found that new firms are more likely to be established and survive when they are 'related', in terms of knowledge bases, skills and organizational practices, to the current industrial configurations of regions (F Neffke, Henning, & Boschma, 2011). The importance of 'relatedness' is substantiated also in research linking the innovativeness and productivity of firms to the composition of the surrounding economy (Aarstad, Kvitastein, & Jakobsen, 2016), and in work finding the productivity (Timmermans & Boschma, 2014) and innovation capacity effects (S. Herstad & Sandven, 2015) of mobility flows between firms contingent on the 'relatedness' of dispatching and receiving industrial domains.

To some, strong regional path-dependencies gives reason to question the potential for policy to achieve much more than providing support at the margins. To others, this research underscores the value of specialised regional knowledge bases and the strong innovation potential of cross-sectorial knowledge flows (Coenen et al., 2016). Acknowledging the potential for radical innovation based on (previously) *unrelated* knowledge combinations, third-party knowledge diffusion infrastructures are in this perspective important because they broaden local knowledge diffusion beyond domains identified

as related today. This is not a trivial point, as diffusion through mobility flows and informal networks tend to be asymmetric (Giuliani & Bell, 2005) and occurring most intensively within rather than between established industry segments (S. Herstad & Brekke, 2012). Following this line of reasoning, emerging 'smart specialization' approaches to regional development emphasizes the importance of mechanisms and initiatives that allow regions to explore 'entrepreneurial' opportunities at intersections between existing resources, and in this way diversify into new industrial domains. Consequently, **a first important role of RIS that can be deduced from recent theoretical advances is to broaden and strengthen inter-sectorial knowledge diffusion and recombinant innovation beyond what occurs through local labour market mobility, supply chain linkages and regional 'information buzz'**. By implication, regional innovation *systems* should be distinguished from **specialised regional innovation networks** that are dominated by a very limited range of sectors and thus cannot be assumed to link different domains of the regional economy.

Second, and related, research on innovation-based development tend to either emphasize the importance of 'analytical' (science-based, disciplinary) knowledge bases, or, alternatively, argue that development is dependent foremost on the 'synthetic' knowledge bases that are application-oriented and built cumulatively through individuals' and firms' experiences with operating in certain industrial domains (B. T Asheim, Boschma, & Cooke, 2011; B.T Asheim & Coenen, 2005). To this, many observers now add the importance of 'symbolic' knowledge bases that are related to aesthetics, culture and design and often highly localized. Lately, research has been converging on a view that combinations of different types of knowledge bases are important if regions are to establish and sustain positive development paths (Grillitsch, Martin, & Srholec, 2016; Manniche, Moodysson, & Testa, 2016). In this perspective, the importance of analytical (science-based) knowledge bases is linked to how interactions with synthetic and symbolic knowledge production can provide the basis for radical innovations and reduce the risk of regional lock-in to decreasing return paths. Accordingly, **a second important role of RIS is to ensure that localized 'synthetic' and 'symbolic' knowledge bases, developed and exploited on an ongoing basis through DUI-type processes, are enriched by 'analytical' knowledge and more explorative efforts that reflect the STI mode of innovation.** This interplay between exploration and exploitation (Levinthal & March, 1993) distinguishes a regional networked innovation system from a territorially embedded innovation network, and from approaches emphasizing linear technology transfers from the research system to industry.

Finally, much research now argue that the performances of individual firms depend on international linkages more so than regional ones (Ebersberger, Herstad, Iversen, Som, & Kirner, 2011; R.D Fitjar & Rodríguez-Pose, 2012; S. Herstad, Bloch, Ebersberger, & van de Velde, 2008), and question the idea that proximity is conducive to particularly creative 'information buzz' between firms and industries (Rune Dahl Fitjar & Rodríguez-Pose, 2016). However, this line of reasoning fails to account for the role of the local economy in supporting, or constraining, the international network ties of firms (Fernhaber, Gilbert, & McDougall, 2008; S. Herstad & Ebersberger, 2015; Johanson & Vahlne, 2009) – and the role of international ties in enriching the content of local networks (e.g. Balsvik, 2011; van Pottelsberghe de la Potterie & Lichtenberg, 2001). As spillovers from local nodes in global networks requires a regional knowledge diffusion capacity to be absorbed and exploited (Meyer & Sinani, 2009), **a third important role of RIS that has recently been acknowledged is to serve in support of internationalization and capture spillovers from global network nodes and ensure that they diffuse in the local economy** (S. Herstad, Bloch, Ebersberger, & van De Velde, 2010). Taking the perspective of regions rather than individual firms means that the contradiction between RIS construction and firms' dependence on linkages to GINs dissolves as focus is on the symbiotic relationship between local knowledge dynamics and international network ties (Bathelt, Malmberg, & Maskell, 2004).

Thus, the objective of a RIS is to support regional industrial development by strengthening knowledge diffusion across sectorial and institutional divides, (explore 'related variety'); provide the basis for knowledge exploration and exploitation based on combinations of analytical, synthetic and symbolic forms of knowledge (combinatorial knowledge bases and ambidexterity) and allow the global network

linkages for regional firms and institutions to feed into local knowledge dynamics (strengthen local buzz through global pipelines).

The RIS approach demands a lot from the side of research system institutions and leading industrial sectors in terms of mobilization and coordination towards long-term collective goals, that may be at odds with the more immediate individual objectives, commercial or scientific, of participants. To the extent that these preferences and objectives are influenced by policy, they are likely to reflect the national R&D and industrial policies that are beyond the control of regional authorities. Thus, a complementary rather than contradictory relationship between national policies and regionalized innovation policies is required in order for initiatives aiming to build RIS are to succeed.

1.3 RIS, innovation policy and the Norwegian system of innovation

A unique feature of the Norwegian economy is the applied research institute sector that has evolved in dense interaction with incumbent industries (cf. Narula, 2002) and grown to be become very large by international standards. The sector remains dominated by SINTEF, headquartered alongside the dominant technical university in Trondheim and one of Europe's largest applied research institutes. Prior research and evaluations have suggested that innovation funding through the large, national R&D programs administered by the Research Council of Norway strengthen foremost the relationships between incumbent industries and a limited number of national champion research institutions (Claussen, 2009; Claussen, Rasmusse, Steinmo, & Jakobsen, 2011; Holst Volden, Bull-Berg, & Gabriel, 2011; Narula, 2002; Strand & Leydesdorff, 2013). Illustrated by the concentration of Norwegian R&D investments in Trondheim and the Capital, this means that Norwegian innovation policy generally **draw in the direction of centralisation and regionalisation of the national innovation systems more so than networked regional innovation systems.**

Still, Norway has a strong tradition for innovation-based regional development policies, which is reflected in regionalization of selected innovation policies and tools. Because of this, a number of initiatives and measures counterbalance the forces of centralisation and specialisation built into R&D and industrial policy in general. Chief among these are the ARENA and Centres of Expertise programs, administered by Innovation Norway, the VRI program of the Research Council and the recent establishment of regional research funds targeting broad-based regional mobilisation into R&D.

This co-existence of centralisation (of RD&I policy and industrial policy) and regionalisation (of *innovation-based* regional development policies) reflects the division of labour between different ministers with different responsibilities, logics and traditions. On the one hand, the Ministry of Research and Education administers R&D and education policy formulated and implemented at the national level, with weak emphasis on innovation. This is paralleled by the Ministry of Trade and Fisheries' (former Ministry of Trade & Industry) responsibility for industrial policy formulated and implemented at the national level, were a strong emphasis on capturing the current value creation potential of the economy result in a weak emphasis of policy on long-term implications for innovation capacity and new path creation. On the other, in the current Ministry of Local Government and Modernization (MGM), a strong emphasis on innovation-based regional development policies remains a legacy from its antecedent. The fragmentation of policies and tools that has resulted from the different rationalities of the different ministers has been reinforced by the absence of a single coordinating public agency responsible for innovation policy implementation. Instead, three different and weakly coordinated state agencies (The Research Council, (RCN), Innovation Norway (IN) and SIVA) are, in addition to public administration at national and county levels, responsible for different yet fundamentally inter-related aspects of R&D, innovation and industrial policy.

A result of this division of labour is polarization between policies and tools administered by RCN that aim at stimulating STI-based exploration efforts under the assumption that DUI-type exploitation capacity is already present in the economy, and efforts administered by IN and SIVA that aim at

stimulating DUI-type innovation activity without much attention to the need for complementary STI-type exploration. Reflecting this, prior research has suggested that there is in Norway a mismatch between centralisation of research and public funding (STI), and a much more distributed and differentiated landscape of innovation based on DUI-type capabilities (Strand & Leydesdorff, 2013). Already during the early 2000s, it was suggested that a 'systemic lock' existed between national champion institutions and a limited number of incumbent industries (Narula, 2002). This is important to note, because it means that the VRI program, which reflect the strong tradition for innovation-based regional policies inherited by the current MGM, has operated in a context where other initiatives and measures draw in very different directions.

1.4 Regional knowledge bases and skill-relatedness

The overall objective of RIS is mobilization of region-specific knowledge bases; strengthening of these knowledge bases through systematic research (the narrow definition of RIS) and exploitation of them by *broadening* inter-firm and inter-sectorial knowledge diffusion beyond that occurs merely as a result of geographical proximity (the broad definition of RIS). This demands attention to the composition of regional employment that structure ongoing processes of industrial learning and knowledge diffusion between firms and sectors through the labour market. Mobility i) transfers knowledge and skills developed at one place of employment to another, ii) lead to the formation of interpersonal ties between firms that continue to transfer information long after the mobility event itself, and iii) exposes firms to behavioural attributes shaped by individuals' prior career paths (Agrawal, Cockburn, & McHale, 2006; Bouty, 2000; Dokko, Wilk, & Rothbard, 2009; S. Herstad, Sandven, & Ebersberger, 2015)

Since Frenken and colleagues (2007) introduced the concept of 'related variety' into the debate on the benefits of regional specialisation ('localisation economies') versus diversity ('urbanization economies') (Frenken et al., 2007), much research attention has been devoted to exploring the conditions under which flows of employees within and between industries influences the performance of firms and the development paths of regions. A central assumption in recent empirical work on this topic is that workers are most inclined to move within and between industries in which their acquired skills are valued, and that skills are valued according to their impact on the performances of businesses. From this follows that data on local mobility can be used to identify the region-specific knowledge dynamics of inter-industry cross-fertilization (Rune Dahl Fitjar & Timmermans, 2016) that represent the point of departure for RIS construction.

1.5 Dimensions of RIS

To capture evolving innovation *systems*, several dimensions must be considered simultaneously. The first is regional mobilization into development work; i.e. the extent to which local firms are actively engaged in exploring new knowledge and in exploiting this knowledge commercially through the introduction of new products and production processes. The concept of 'innovation activity' refers to efforts beyond a certain (high) threshold, and reflect the routing structure implemented in early rounds of the 'Community Innovation Survey' (S. J. Herstad, 2017). While this is a strict empirical operationalization, considering it explicitly is a response to the critique of lacking focus on the micro-foundations of RIS that are learning work organizations and the willingness of firms to invest in innovation (Coenen et al., 2016).

The second dimension is the evolution of local linkages. Reflecting the distinction between a narrow and a broad definition of RIS, it is necessary to consider mobilisation into local industrial networks (DUI dimension of RIS) and university-industry linkages (STI dimension of RIS). To capture the regionalization of national innovation systems and acknowledging the need for regions to access information, technology and knowledge from outside, the third dimension is extra-regional linkages at the national and international levels.

Finally, while contemporary RIS theory emphasises the importance of ‘related variety’ and cross-sectorial linkages, this dimension has largely been neglected in policy implementation and empirical research emphasising mostly the existence or not of local networks instead of considering their composition and thus content. In response, there is a need to consider whether local networks are exclusive to certain industries (‘specialised regional innovation networks’), or build on the actual micro-foundations for RIS construction that are present (‘networked regional innovation systems’).

1.6 Data and methodological approach

1.6.1 Regional development paths and revealed skill relatedness

Regional development paths are described by using register data to compute location quotients for each industry group in the years 2006, 2008, 2010 and 2012. A location quotient is a region’s shares of domestic employment in a given industry group, over the regions share of all domestic employment. Thus, they take on values above 1 if employment is over-represented, meaning that the region is specialised in the industry. Revealed skill-relatedness, i.e. the industrial sectors that are most intensively cross-fertilizing each other through the labour market, is analysed fusing data on regional (within the different VRI regions) labour market mobility generated from the Linked Employer Employee (LEED) register for the period 2002-2012. This reflect the period for which innovation activity and networks are analysed, and is used to avoid influences from specific labour market events.

For the sake interpretability and reflecting the objective of providing an overview of regional knowledge dynamics, a simplified version of the approach initially developed by Neffke and colleagues (2013) and later applied to Norwegian regions in Fitjar & Timmermans (2016) is used. It focuses on mobility flows between the industry groups that are described in Table 1-2 below and later used in the analysis of innovation. Industry groups not covered by the harmonized CIS data are also included in the analysis of sector growth and revealed skill relatedness.

For each industry group, a mean mobility score is computed as the average of observed total inflows and observed total outflows during the whole period. The expected (assuming statistically independent distribution of regional mobility within and between industry groups) exchange within each possible industry pair (e.g. A and B) is computed as the mean total mobility of A multiplied with the mean total mobility of B, divided by the total number of mobility events recorded in the region during the period.

The observed mobility between A and B is then computed as the average of actual inflows from sector B to A and actual inflows from sector A to B. When divided by expected mobility between the two industries, the resulting ratio expresses the degree to which labour mobility between the two signal skill-relatedness. As it is not the pairs as such that are of interest but the clusters of skill-related industries that characterizes regions, social network analysis software is used to graphically describe these clusters (Rune Dahl Fitjar & Timmermans, 2016). It must be noted that this procedure does not capture the intensity of mobility flows, but the sector preferences of occurring mobility flows.

1.6.2 Innovation

Analyses of innovation activity and networking are based on data from the Community Innovation Surveys (CIS). CIS data provide information on many aspects of innovation activity and linkages. The Norwegian survey is implemented by Statistics Norway and conducted on a bi-annual basis in accordance with EUROSTAT guidelines. As of CIS2006, which cover innovation activity and output in the years 2004-2006, information on local collaboration is provided. This means that relevant data is available as of the reference period starting in 2004 (CIS2006), until the reference period that ended in 2012 (CIS2012).

Through these different rounds, the CIS itself has been expanded to include a broader range of sectors. Moreover, some sectors have been sampled only in certain waves. To ensure that data from different waves of the CIS can be compared over time, sectors not samples according to the same

criteria in all rounds of the survey have been excluded from the analysis. The resulting 'harmonized CIS sample' consists of enterprises with more than five employees which operate in the industry groups that are marked with grey in Table 1-2 below.

1.6.3 Regionalization

LEED data contain information on all enterprises (the legal entity) and establishment (single business unit in a single physical location) in Norway. CIS data, by contrast, is a sample of *enterprises* with more than 4 employees. Enterprises may conduct their businesses in multiple establishments that are located in different regions, and be assigned to different industry groups (S. Herstad & Ebersberger, 2013, 2015). Thus, collaboration maintained by establishments located in one part of Norway may therefore be reported by enterprises that are legally registered in other parts of the country. In Norway, this phenomenon leads to over-reporting of activity in the Capital region (S. J. Herstad, 2017).

This means that CIS data as such cannot be regionalized. However, Norwegian multi-establishment enterprises are in the survey questionnaire required to provide information on the contribution of their individual business units ('establishments') to development work. Based on this, information on the innovation activities and collaboration patterns of the enterprise can be assigned to the individual establishment that were reported to be actively involved in development work. The result is a dataset on innovation activity and employment at the establishment level, consisting of sampled *enterprises with more than 4 employees and no restrictions imposed on the size of establishments*. Table 1-1 below gives for each round of the CIS the unweighted and weighted number of establishments. The unweighted number is establishments sampled; while weighted is the number of establishments that these are meant to represent.

Table 1-1 Number of observations (establishments)

	CIS2006	CIS2008	CIS2010	CIS2012
Unweighted (sample)	9 311	9 354	9 353	9 533
Weighted (population)	20 464	19 046	18 288	18 209

This establishment-level information can be assigned to the 428 Norwegian municipalities and aggregated to the 15 VRI regions as exemplified in Figure 1-2 below.

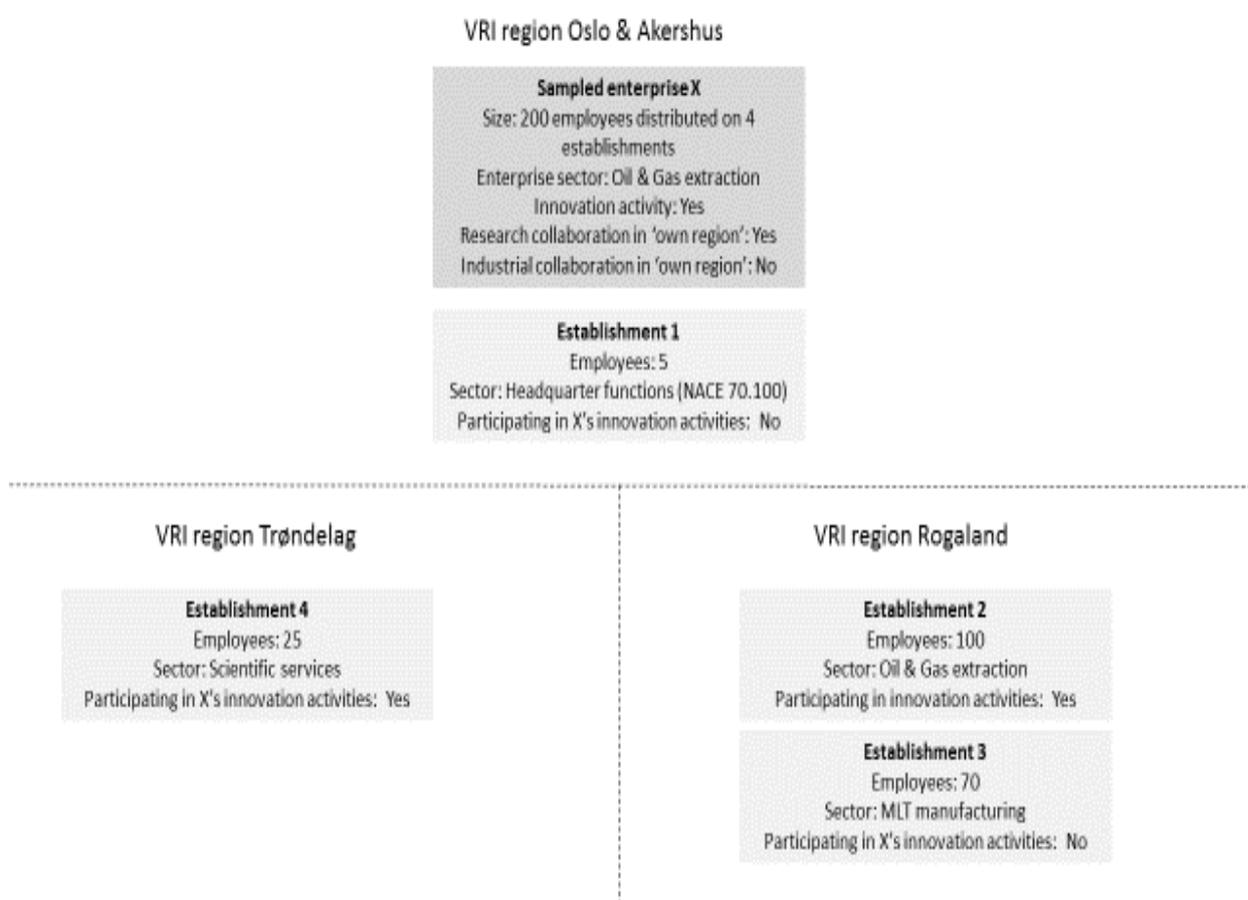
1.6.4 Enterprises or establishments vs. employees as unit of measurement

Using the harmonized CIS sample, it is straightforward to estimate the proportion of establishments that in each VRI region and wave of the CIS were engaged in innovation activity and different types of collaboration, and assume that this describes evolving RIS configurations. However, the territorial knowledge bases that the RIS approach seek to develop and exploit ultimately resides with individuals. It reflects their educational backgrounds, career paths that are shaped by the industrial composition of regions and the innovation strategy choices made by employer firms. In response to the growing recognition of *people* and their experiences as the primary foundation of innovation (Ron Boschma, Eriksson, & Lindgren, 2014; S. Herstad et al., 2015; Rutten & Boekema, 2012; Solheim & Herstad, 2016; Timmermans & Boschma, 2014), the analysis herein deviate from the common practice of analysing proportions-of-firms that are engaged in activities of interest. Instead, it analyses the proportion of *employees* in each region that are engaged in firms, i.e. establishments, with the activities of interest. As such, it acknowledges that regional knowledge bases and the knowledge are intimately interlinked with how the work-life experiences of people are shaped by choices made by their employer firms, and that the impact of firm choices on regional dynamics is stronger the larger the proportions of employment they concern.

1.6.5 Example

Figure 1-1 below illustrates the regionalization procedure and the measurement unit issue. The example is an enterprise operating in the Oil & Gas extraction industry, which is registered in the Capital region of Oslo & Akershus with 200 employees and reported local research system collaboration in the CIS. As can be seen from the figure, the actual business activities of the enterprise is in the Capital limited to 5 employees in administrative functions that the enterprise itself state are not involved in innovation activities. The remaining 195 employees are distributed on one establishment in Trøndelag with 25 employees, one establishment in Rogaland with 100 employees and one establishment in Rogaland with 70 employees. Because only the two former are reported to be involved in innovation activities, this counts as 125 innovation-active employees in total, of which 25 are in Trøndelag and 100 are in Rogaland (as opposite to 200 in Oslo & Akershus).

Figure 1-1: Regionalization of a multi-establishment enterprise sampled in the CIS



As the data does not allow precise determination of where research system collaboration in the 'own region' of the enterprise actually occurred, all active establishments are assumed to be engaged in such collaboration, in their respective regions.

1.6.6 Sectors

In order to capture what types of economic activities that shape the knowledge bases of different regions, it is necessary to implement a classification of sectors. This classification must on the one hand be sufficiently fine-grained to have analytical value. On the other, low numbers of observations in some of the smaller VRI regions prohibit the use of a very fine-grained taxonomy because reported statistics would violate data disclosure rules.

The standard for industry classification changed from NACE 2002 to NACE 2007 as of the CIS2008 round. A procedure for recoding CIS (and LEED) industry classifications from the old to the new standard has been developed and implemented. To recode the industry classifications in CIS2006 to the later standard, the dual industry classifications provided by Statistics Norway in the CIS2008 only is used as the key. For other industries, LEED data is used to change each original industry code to the NACE 2007 code most commonly given to firms in each specific NACE 2002 group when the classification changed.

These NACE codes have then been used to create the aggregate sector groups that are described in Table 1-2 below, where grey indicates inclusion in the harmonized (comparable-between-waves) CIS sample. The different types of services covered by the CIS are in addition to Oil & Gas extraction distinguished from manufacturing, which in turn is classified in accordance with the OECD technology intensity taxonomy. This taxonomy is based on the direct R&D intensity of sectors as well as their dependence on R&D embodied in intermediate and investment goods (Ejermo, Kander, & Svensson Henning, 2011; Hatzichronoglou, 1997) and should therefore not be confused with knowledge intensity or complexity of output.

Table 1-2 Overview of sector groups. Grey indicate sectors that are included in the harmonized CIS data used.

Short name	Sector	NACE 2007
Primary	Agriculture	NACE 011-017: Agriculture
	Forestry	NACE 021-024: Forestry
	Fisheries	NACE 031: Fisheries
	Aquaculture	NACE 032: Aquaculture
Mining	Mining & Quarrying	Extraction of minerals & related services
Oil & Gas	Oil & Gas	NACE 061: Extraction of crude oil
		NACE 062: Extraction of natural gas
		NACE 091: Related services
HT manufacturing	High-tech manufacturing	NACE 21: Pharma NACE 26: Electronics & instruments NACE 303: Aerospace
MHT manufacturing	Medium high tech (MHT) manufacturing	NACE 20: Chemicals NACE 27: Electric equipment. NACE 28: Specialized machinery NACE 29: Automotive NACE 302: Railway equipment NACE 304: Combat vehicles NACE 309: Other transportation equipment.
MHT manufacturing	Medium low tech (MLT) manufacturing	NACE 19: Petrochemicals NACE 22: Rubber products NACE 23: Glass NACE 24: Metals NACE 25: Metal products NACE 301: Maritime NACE 31: Furniture NACE 32: Medical, sports and other equip., musical instruments. NACE 33: Repair
LT manufacturing	Low tech (LT) manufacturing	NACE 10: Food NACE 11: Beverages NACE 12: Tobacco NACE 13: Textiles NACE 14: Clothing NACE 15: Leather & Shoes NACE 16: Wood NACE 17: Pulp & Paper NACE 18: Printing
Infrastructure	Infrastructure, energy & environment	NACE 351: Electricity (production, distribution, sales) NACE 352: Gas (production, distribution, sales) NACE 353: Steam & hot water NACE 36: Water NACE 38: Waste treatment. & recycling NACE 39: Other environmental. services
Construction	Construction	NACE 41: Buildings
		NACE 42: Roads, railways, bridges & tunnels
		NACE 43: Demolition
Trade	Wholesale trade	NACE 45: Trade & repair of motor vehicles NACE 46: Wholesale trade except motor vehicles
	Retail trade	NACE 47: Retail trade except motor vehicles
Transportation	Transportation	NACE 49: Land-based
		NACE 50: Sea-based
		NACE 51: Air transport

		NACE 52: Storage and other services NACE 53: Postal & distribution
ICTs	Information & Communication services	NACE 68: Publishing NACE 69: Movies & television NACE 60: Broadcasting NACE 61: Communication NACE 62: ICT Services NACE 63: Processing & maintenance
Finserv	Finance, insurance & real-estate services	NACE 64: Investment services NACE 65: Insurance NACE 66: Trade & brokering NACE 68: Real-estate
Techserv	Administrative, technical and Scientific Services	NACE 70: Management consultancy NACE 71: Technical consultancy NACE 72: R&D services NACE 73: Advertising NACE 74: Other technical/professional services
Othserv	Other business services	NACE 77: Leasing & rental NACE 78: Staff services NACE 79: Travel agencies NACE 80: Security & private investigations NACE 81: Real-estate services NACE 82: Other
Pubadm	Public administration & defence	NACE 841: Public administration NACE 842: Security & foreign affairs NACE 843: Welfare security services
Education	Education	NACE 85: Education
Healthcare	Healthcare	NACE 86-88: Healthcare
Personal & Creative	Personal & Creative	NACE 90: Artistic & entertainment NACE 91: Libraries, museums, etc. NACE 92: Lotteries NACE 93: Sports & Leisure NACE 94: Membership organisations NACE 95: Repair services NACE 96: Other personal services

1.6.7 Empirical measures of innovation activity and collaboration

Following the theoretical discussion above, the three dimensions described in the upper part of Table 1-3 below are of particular interest. The first dimension is simply the proportion of regional employment that occurred in innovation-active firms, computed for the periods 2004-2006 (CIS2006), 2006-2008 (CIS2008), 2008-2010 (CIS2010) and 2010-2012 (CIS2012). This indicator is a strict empirical operationalization of the micro-foundations for RIS construction that is employment in learning work organizations. Note that 'innovation activity' as defined in Table 1-3 below include but is not limited to firms that have successfully 'innovated'.

The second dimension concerns the distinction between a narrow and a broad RIS. To capture the narrow definition of RIS that is R&D-based innovation collaboration according to the STI mode, the proportion of innovation-active regional employment that occurs in firms that maintain collaborative linkages with research institutions, locally and at larger geographical scales, is used as empirical indicator. Given the low proportion of firms that engage in R&D as strictly defined in the Frascati Manual, it reasonable assume that industrial networks are dominated by non-R&D collaboration, and thus reflect the broad definition of RIS that is innovation according to the DUI mode. Thus,

collaboration involving industrial actors (clients, suppliers, competitors) is used to construct indicators describing RIS according to the broader definition.

The third dimension concerns the degree of industry specialisation in RIS configurations, relative to the degree of specialisation in innovation-active employment and the regional industrial structure as a whole.

To describe these dimensions empirically, the three measures described in the lower part of Table 2 are used. CONTRIBUTION is simply the weight of each individual sector group, in each of the dimensions of interest. Thus, it describes who the sectors dominating each activity dimensions are. Because this measure is highly sensitive to the overall size of sectors, the measure COMMITMENT is used to capture whether sectors account for more or less activity along the different dimensions than would be expected from their employment size.

The Community Innovation Survey defines collaborative linkages as “*active participation with other enterprises or institutions on innovation activities*” and specifies that “*pure contracting out of work with no active co-operation*” is to be reported as innovation sourcing, not collaboration (Ebersberger & Herstad, 2011). This is important to note, because it means that the survey information on collaboration capture the intentional, committed and interactive relationships that define a working RIS and distinguishes it from other types of inter-firm or university-industry linkages such as contract R&D and technology transfer initiatives.

To capture the degree of specialisation in RIS linkages in different regions, Herfindahls index is used to operationalize the measure CONCENTRATION. It takes on the value 1 when one single sector group account for all activity of a certain type. Because there is in our case 14 different sector groups on which activities may be evenly distributed, the minimum degree of CONCENTRATION is $1/14 = 0.07$. When interpreting concentration scores, it must be kept in mind that they influenced by the size of the region and generally lower the larger the region is.

Table 1-3 RIS dimensions and indicators

Main Dimensions	Definition
Micro-foundations for RIS: Employment in innovation active organizations	Employment occurring in firms with at least one of the following characteristics: <i>Positive innovation expenditures, successful innovation outcomes (new goods or services, new processes or support functions), ongoing, not-finalized innovation projects or abandoned innovation projects.</i>
The narrow definition of RIS: Research system collaboration	Employment occurring in firms that maintain collaboration with universities, research institutes and R&D laboratories at either one of the three different spatial scales: -locally, i.e. in what firms perceive as their 'own region' -domestically outside firms' own regions -internationally
The broad definition of RIS: Industrial collaboration	Employment in firms that maintain collaboration with clients, suppliers, competitors or consultancy firms at either one of the three different spatial scales: -locally, i.e. in what firms perceive as their 'own region' -domestically outside firms' own regions -internationally

Indicators	Definition	Values
CONTRIBUTION	The proportion of activity along each dimensions described above that is accounted for by each of the sector group described in Table 2	Bound between 0 (no activity) and 1 (all activity accounted for by a given sector group)
COMMITMENT	Sector proportions of activity along each of the dimensions described above relative to sector proportion of innovation active employment	Values above 1 means that the sector account for more activity along a given dimension than would be expected from its size
CONCENTRATION	Herfindahls concentration index. Describes the extent to which activity along each of the dimensions described above is dominated by a limited number of sectors.	Bound between 0.07 (employment with activity is evenly distributed on all 14 industrial sectors) and 1 (one single industrial sector account for all activity)

2 Aggregate analysis of system dynamics in Norwegian VRI regions

2.1 The Norwegian economy

2.1.1 *Industry structure & skill-relatedness*

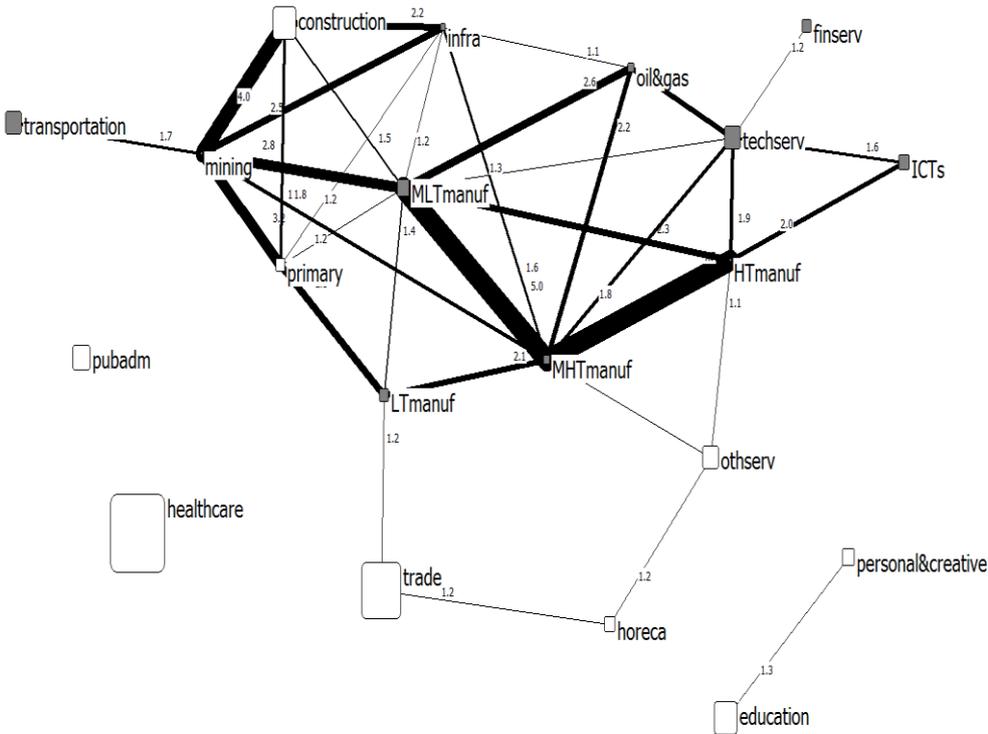
Norway is a small, open and high-income economy specialized in deep-water oil and gas extraction technologies, seafood, maritime equipment, ammunition and weapons systems, and metallurgical industries (e.g. Benito, Larimo, Narula, & Pedersen, 2002; Castellacci & Fevolden, 2014; Fagerberg, Mowery, & Verspagen, 2009). These are largely engineering-based; characterized by cumulative knowledge development and continuous innovation aimed at problem solving in specific contexts of technology application. Throughout the period considered, the Norwegian economy exhibited exceptionally strong growth and total employment increasing 8 per cent (Cf. Table 2-2). This was partly driven by the vast expansion of the Oil & Gas sector due to exploration of technologically complex marginal fields in the wake of high international energy prices, and resulting growth impulses into technology supplying manufacturing and services industries: From Table 2-2, it is evident that employment in the Oil & Gas sector narrowly defined more than doubled during the period. As a result, Norway experienced the strongest 1998-2008 increase in sector specialisation of all OECD economies (B. Asheim & Herstad, 2014).

Table 2-1 The composition of employment in the Norwegian economy. Sectors marked with grey are included in the harmonized CIS sample.

	Sector proportion of employment				Employment growth
	2006	2008	2010	2012	2006-2012
Primary	3,36 %	3,08 %	2,79 %	2,57 %	-17,25 %
Mining & Quarrying	0,17 %	0,17 %	0,18 %	0,19 %	21,49 %
Oil & Gas	0,86 %	1,05 %	1,37 %	1,60 %	100,75 %
HT manufacturing	0,53 %	0,51 %	0,47 %	0,45 %	-8,80 %
MHT manufacturing	1,75 %	1,69 %	1,60 %	1,65 %	2,04 %
MLT manufacturing	4,53 %	4,60 %	3,93 %	3,87 %	-7,34 %
LT manufacturing	3,72 %	3,40 %	3,22 %	3,03 %	-11,76 %
Infrastructure	1,06 %	1,04 %	1,10 %	1,13 %	15,57 %
Construction	7,31 %	7,66 %	7,96 %	7,97 %	18,09 %
Trade	15,07 %	15,01 %	14,41 %	14,21 %	2,23 %
Transportation	6,03 %	5,83 %	5,76 %	5,55 %	-0,19 %
Horeca	3,24 %	3,18 %	3,22 %	3,19 %	6,72 %
ICTs	3,36 %	3,49 %	3,46 %	3,56 %	14,94 %
Financial Services	2,99 %	3,04 %	2,94 %	2,91 %	5,29 %
Administrative, technical & Scientific services	4,46 %	4,86 %	4,95 %	5,17 %	25,68 %
Other services	4,93 %	5,23 %	5,35 %	5,15 %	13,01 %
Public administration	5,70 %	5,65 %	5,92 %	6,14 %	16,69 %
Education	7,90 %	7,80 %	7,91 %	7,96 %	9,18 %
Healthcare	19,51 %	19,16 %	19,78 %	20,00 %	11,10 %
Personal & Creative services	3,52 %	3,55 %	3,69 %	3,72 %	14,33 %
Total employment	2 356 995	2 495 264	2 548 866	2 554 151	8,36 %

The interrelatedness of the Oil & Gas industry and other manufacturing and services industries in the Norwegian economy is evident from mobility flows in the economy during the 2002-2012 period. Figure 2-1 shows that the Oil & Gas sector, manufacturing industries and technical services sector comprises a cluster of skill-related industries that is defined by intense exchanges of human resources.

Figure 2-1 Inter-industry skill-relatedness in the Norwegian economy 2002-2012. Line thickness expresses the ratio of observed mobility over expected mobility, i.e. the degree of revealed skill relatedness. Only linkages where observed/expected > 1.1 are depicted. Node size signifies sector proportion of employment. Grey nodes are sectors included in the innovation analysis. Mobility within each industry group is not depicted.

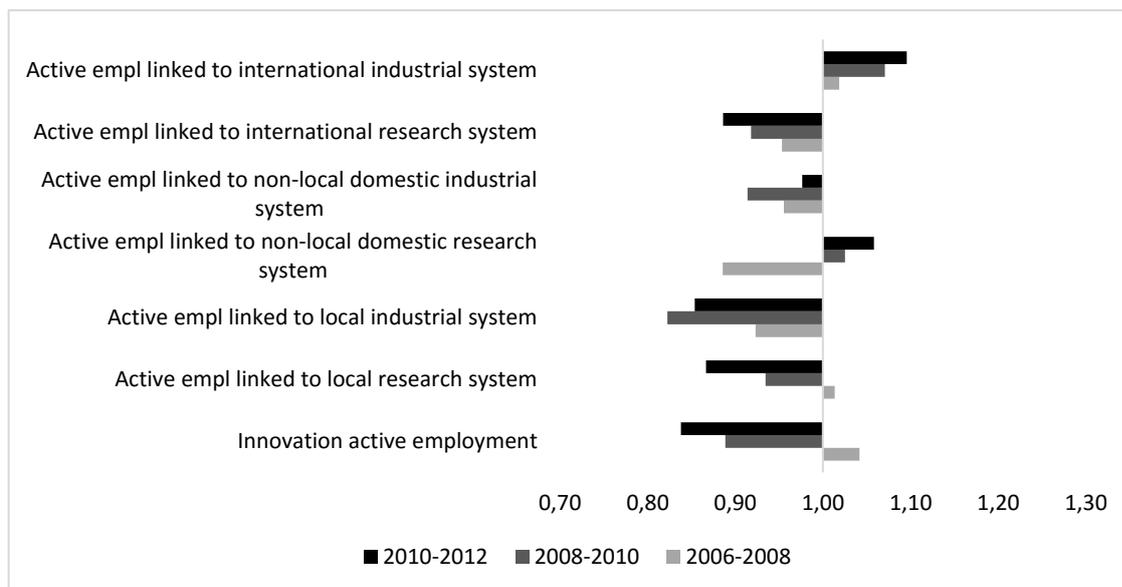


The Oil & Gas sector is strongly related to the MHT and MLT manufacturing industries that are also related with each other and with the Technical & Scientific services. Notably, Oil & Gas emerge as the sector with which Technical & Scientific services are most strongly related. Finally, while the ICT sector is interlinked with Technical & Scientific Services, and thus indirectly with Oil & Gas, it exhibits a particularly strong direct skill-relatedness with the HT manufacturing sector that is relatively small in Norway. As only inter-sector linkages involving larger mobility flows than expected are depicted, the absence of linkages involving public administration and healthcare does not imply that these sectors are detached from the rest of the economy.

2.2 Baseline innovation profile

Figure 2-2 below describes how innovation activity and linkages have evolved in Norway, relative to what was reported in CIS2006, i.e. for the period 2004-2006 and thus prior to influences from VRI. Employment in innovation-active firms increased slightly during the first CIS period in which the VRI program was active, i.e. from CIS2006 to CIS2008; dropped distinctively in CIS2010 and was in CIS2012 16 per cent below the level reported in CIS2006. Thus, a first notable trend in the Norwegian landscape of innovation is a decrease in the proportion of the nations’ human resources that are employed by firms reporting, in the CIS, that they are engaged in development work.

Figure 2-2 Innovation profile for Norway. Proportions of employment relative to period 2004-2006 (CIS4)



Contrary to the overall objective of VRI, the proportion of innovation-active employment that occurred in firms with local research system collaboration declined during the period, and was in 2010-2012 down by 13 per percent compared to the 2004-2006 reference. During the same period, the proportion occurring in firms non-local domestic research system collaboration increased by 6 per cent. Moreover, a decrease occurred in international research system collaboration that was paralleled by an increase in international industrial collaboration and a decrease in industrial collaboration locally and domestically.

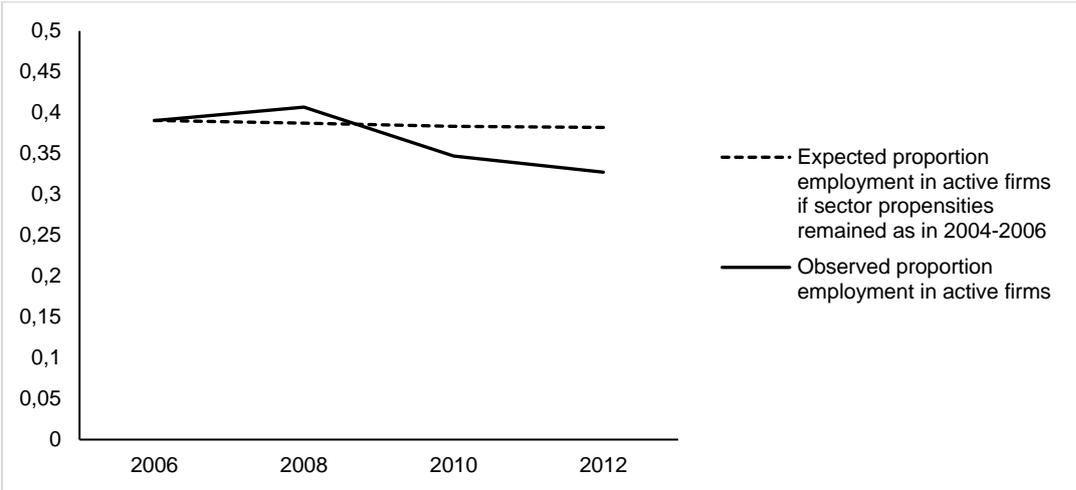
Thus, in terms of the narrow definition of RIS, a shift has occurred away from local and international research system collaboration, towards non-local domestic collaboration presumably favouring the dominant national institutions. In terms of the broader definition, the shift away from local industrial collaboration that co-exists with an unclear trend at the national level has favoured international industrial collaboration.

2.2.1 The micro-foundations of RIS: Innovation activity

Technically, there are two possible explanations for the decrease in innovation active employment. The first is a de facto reduction in the willingness of industry to commit human resources to innovation activities with uncertain outcomes and benefits, which translates into weakened micro-foundations for RIS and suggest that policies have failed in the most fundamental objective that is mobilisation. The second is structural change away from industries that tend to exhibit high levels of commitment to development work (e.g. manufacturing), towards industries with lower or more variable degrees of commitment (e.g. certain types of services).

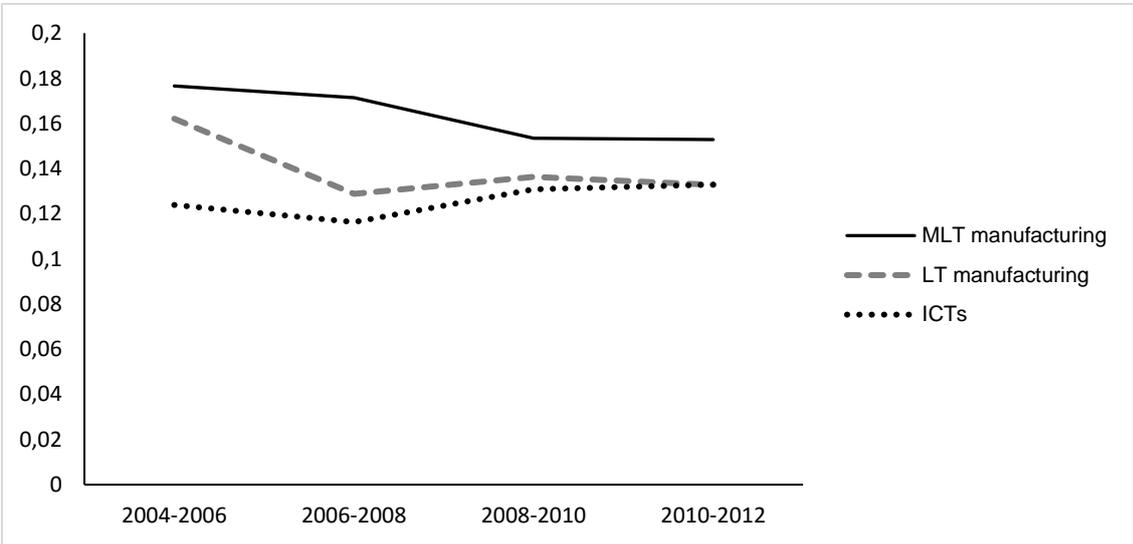
To investigate this, expected innovation activity levels have been computed by applying the sector-specific levels in CIS2006 to the composition of employment covered by the subsequent rounds of the CIS. As can be seen from the dotted line in Figure 2-2 below, the expected effect of structural change in the composition of employment in the CIS is a decrease from 40 per in 2004-2006 cent to 38 per cent in 2010-2012, i.e. marginal. The full line shows that the observed level of innovation-active employment in 2010-2012 (33 per cent) was well below the expected level 38 per cent and the level of 40 per cent exhibited at the outset. This implies that the commitment of Norwegian industry to active development work was reduced during the period.

Figure 2-3 Expected vs. observed innovation activity in Norway



Keeping in mind the limitations of the harmonized CIS in terms of sector coverage, Figure 2-3 below shows that innovation active employment in Norway is dominated by MLT manufacturing, LT manufacturing and ICTs. Combined, these three sectors accounted for approximately 50 per cent of innovation-active CIS employment during the period 2010-2012. The proportion accounted for by the ICT sector increased slightly from the beginning to the end of the period, while the proportions accounted for by MLT and LT manufacturing decreased slightly. As the ICT sector became even more dominant in the Norwegian landscape of innovation during the period, an important question is whether it has been mobilized into regional (or national) collaboration networks.

Figure 2-4 Estimated sector contribution to innovation active employment in Norway. The three largest sectors in 2010-2010 (CIS2012) = the three largest sectors in 2004-2006 (CIS2006).



LT manufacturing, MHT manufacturing and ICTs are large sectors, which as such can be expected to account for large proportions of innovation active employment. The two latter, however, are also among the three dominant sectors measured in terms of COMMITMENT (that is, employment CONTRIBUTION relative to employment size), as they contributed 2 and 1.5 times more innovation-active employment than would be expected from their size. Notably, the HT manufacturing sector contributed 2.3 times more innovation active employment as would be expected from its contribution to innovation activity in general. The levels exhibited by the three most committed sectors increased somewhat through the period. The absence of period-to-period fluctuations imply that these are sectors with a strong, overall commitment to development work in Norway.

Figure 2-5 Estimated sector commitment to innovation activity in Norway. *The three most committed sectors in 2010-2012 (CIS2012), which equals the three most committed in 2004-2006 (CIS2006)*

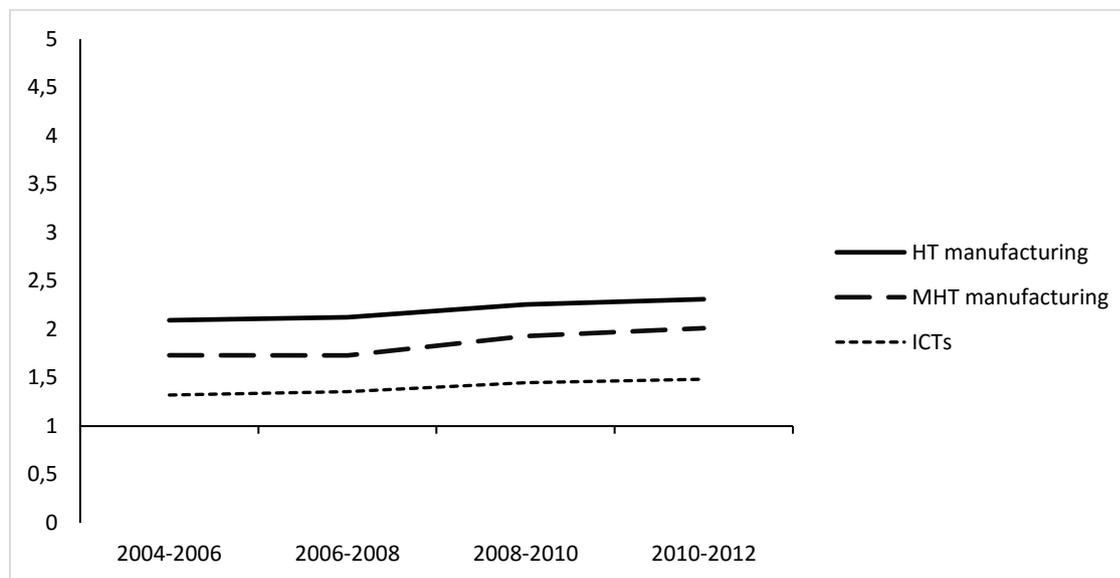
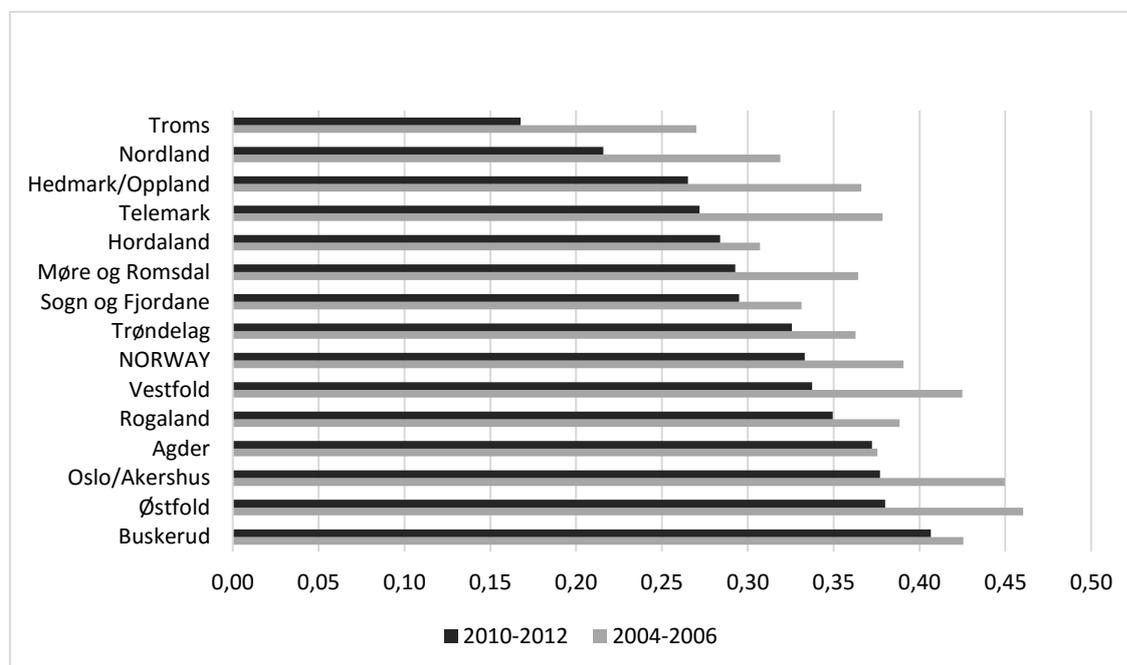


Table 2-10 below describes the proportions of employment that, in each VRI region, were engaged in development work, in CIS2006 and in CIS2012. In 2010-2012, these span from 41 per cent in Buskerud, to 22 per cent in Nordland and only 17 per cent in Troms.

Figure 2-6 Innovation activity by regions. Proportions of all employment ranked by performance in 2010-2012. *Finnmark is not reported due to strong period-to-period fluctuations and limited number of observations.*

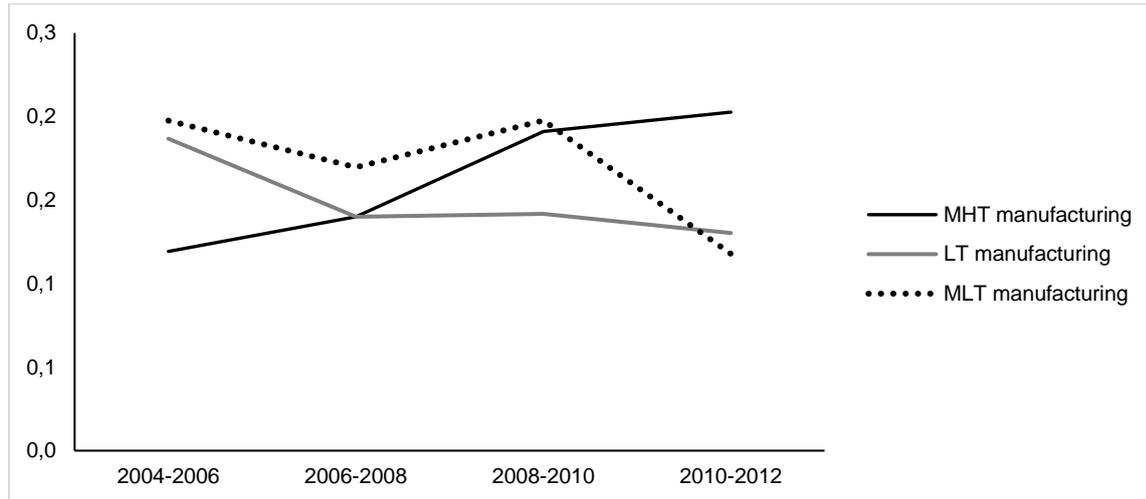


Thus, the micro-foundations for RIS construction vary distinctively across the different Norwegian regions, calling for a differentiated approach to policy where the balance between firm level and network level initiatives is adapted to the micro-foundations at hand and actively work to strengthen them where necessary (S. Herstad et al., 2010).

2.2.2 The narrow definition of RIS

From Figure 2-6, it is evident that local research system linkages throughout the period were dominated by manufacturing industries. The contribution from the LT manufacturing sector is particularly stable, while the MLT sector exhibited some period-to-period fluctuations. The contribution from the MHT manufacturing sector increased steadily, and went up from 11 per cent in 2004-2006 to 20 per cent in 2010-2012. This sector group includes equipment and technology providers to the oil & gas sector.

Figure 2-7 Estimated sector contribution to local research system networks in Norway. The three largest sectors in 2010-2012 (CIS2006), which equals the three largest sectors in 2004-2006 (CIS2006).



Measured in terms of COMMITMENT and thus controlled for sector size, HT manufacturing emerges as strongly oriented towards local research system collaboration. In 2010-2012, it accounted for 5.6 times more than would be expected from its (comparatively small) size. The highly innovation-active ICT sector, by contrast, contributed in 2010-2012 only 40 per cent of what would be expected from its size. The aquaculture industry, which accounted for only 0.7 per cent of employment in CIS2012, accounted also for 2.2 per cent of employment linked to local research system institutions, positioning it among the three most committed. In line with the objective of VRI, the commitment of MHT manufacturing firms to local research system collaboration has increased steadily through the period.

Figure 2-8 Estimated sector commitment to local research system networks in Norway. The three most committed sectors.

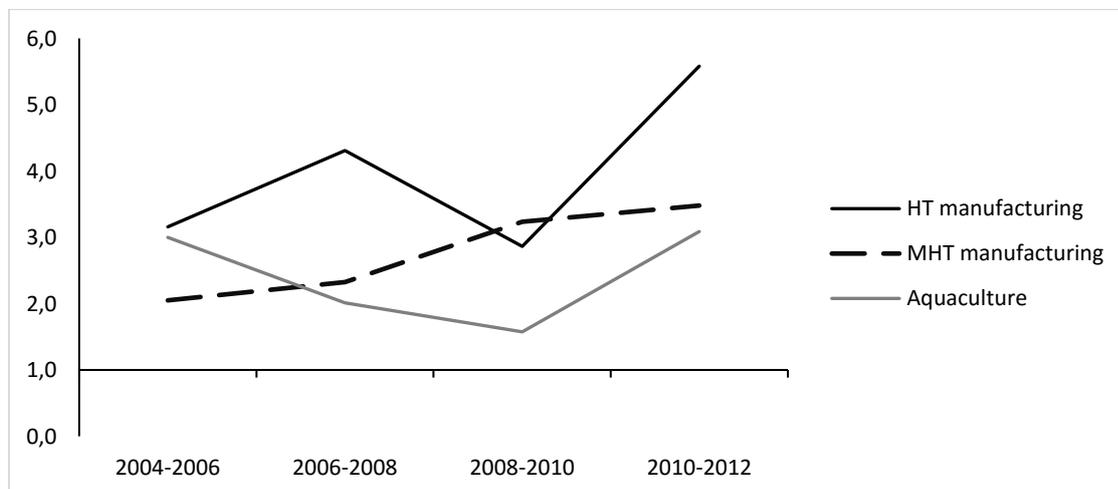
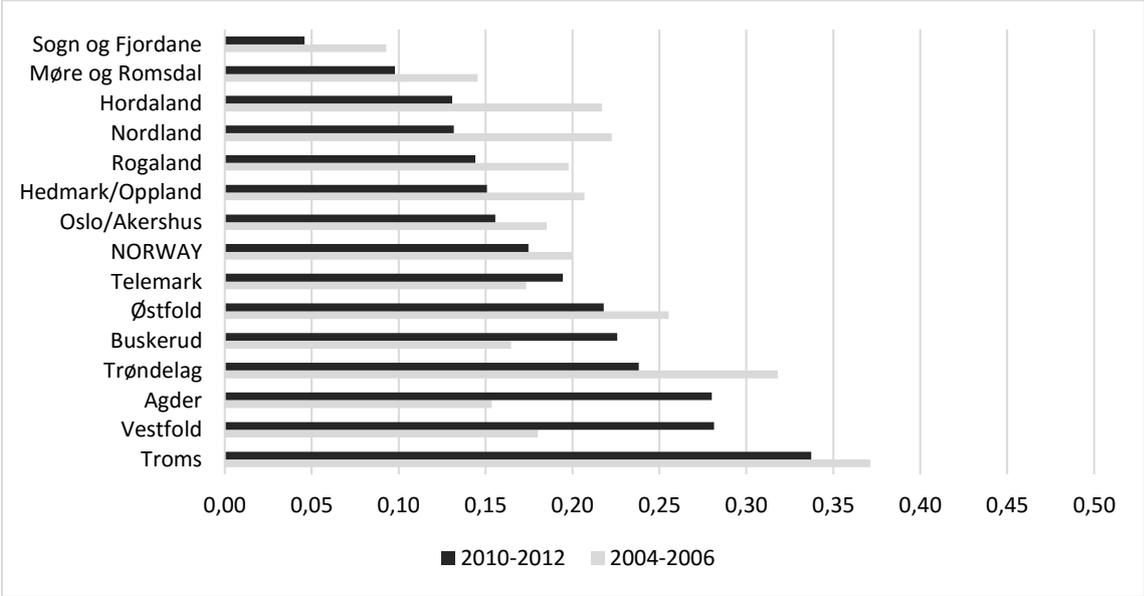


Figure 2-11 below describes local research system collaboration by region. Troms, which is the poorest performing region in terms of active employment, is also the top performer in terms of local research system linkages. This means that the region faces innovation policy challenges very different from those of e.g. the Capital region, where innovation activity is vibrant while local research system networks are comparatively weak in spite of the high-quality institutions present in the region.

Figure 2-9 Local research system collaboration by region. Proportions of active employment, ranked by performance in 2010 – 2012. Finnmark is not reported due to strong period-to-period fluctuations and limited number of observations

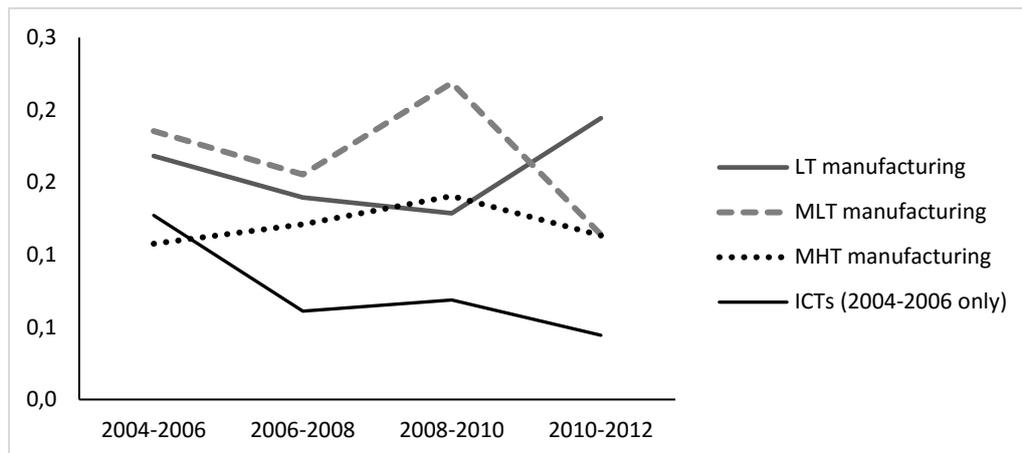


Buskerud, Vestfold and Agder combine innovation activity levels above the national average with strong local research system linkages. In the two latter regions, local research system linkages have been strengthened substantially during the period considered. In Møre and Romsdal, by contrast, what will later be demonstrated is a reorientation of the industrial base towards non-local domestic research system collaboration is paralleled by weakened local research system linkages. This places the region as the second poorest performer in this respect.

2.2.3 The broad definition of RIS

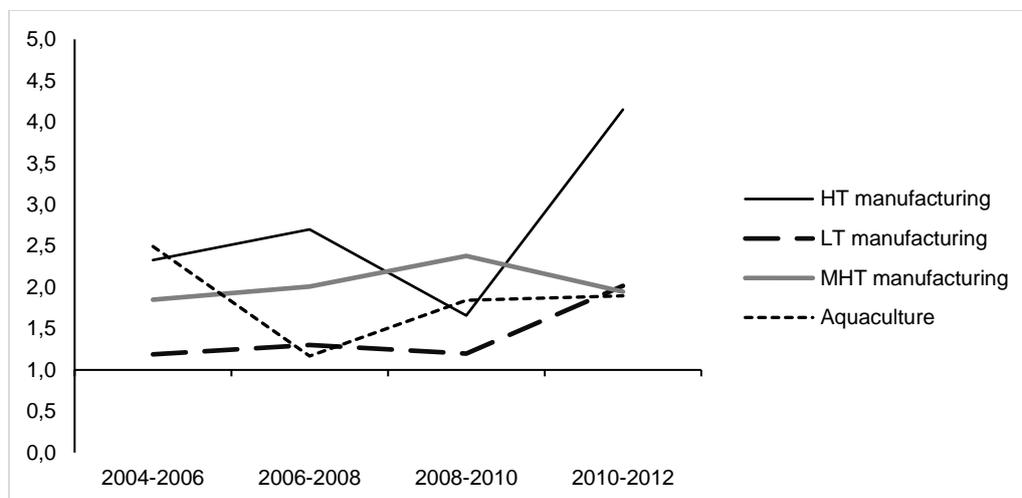
The broader definition of RIS concerns the contribution and commitment of different industrial sectors to local industrial networks. These networks were in 2004-2006 dominated by ICTs (13 per cent of employment), LT manufacturing (17 per cent) and MLT manufacturing (19 per cent). Through the period, the contribution of the ICT sector to local industrial networks declined sharply, and was down to only 4 per cent in 2010-2012. The relative contribution from LT manufacturing, by contrast, increased from 17 per cent at the beginning of the period to 19 per cent at the end of it.

Figure 2-10 Estimated sector contribution to local industrial collaboration in Norway. The three largest sectors.



The ICT sector under-performs also in terms of commitment to the local industrial networks that foremost have mobilized firms in the LT, MHT and HT industries; in addition to firms in the aquaculture industry. Consistent with the objectives of VRI, HT and LT manufacturing industries exhibit stronger commitment levels at the end of the period, than at the beginning; yet, period-to-period fluctuations are strong and thus notable. It is also notable that HT manufacturing firms are among the most committed both to local research system and to local industrial collaboration, and that commitment levels in this industry are higher at the end of the period than they were at the beginning.

Figure 2-11 Estimated sector commitment to local industrial collaboration in Norway. The three most committed sectors.

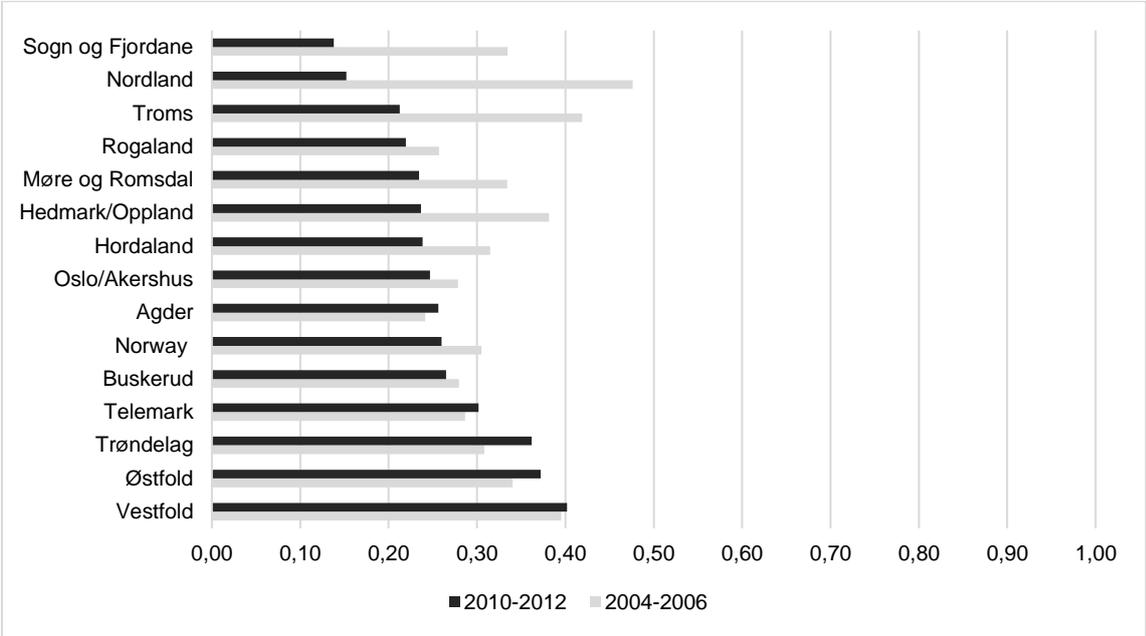


Vestfold, the second top performer in terms of local research system linkages, is also the top performer in terms of local industrial linkages. This suggests that firms in this region have positioned themselves at the intersection between different providers of (different types of) knowledge. Industrial collaboration is also strong in Østfold, Trøndelag and Telemark, and has in these regions been strengthened during the period considered. In Buskerud, it has remained stable at high levels. In Møre & Romsdal, local industrial collaboration has weakened substantially during the period. In the section on this region, it is demonstrated that this is paralleled by strengthened international networks.

Local industrial networks are particularly weak in Sogn & Fjordane, Nordland, Rogaland and Troms. In Troms, an exceptionally low overall level of innovation activity co-exist with weak industrial networks and a strong orientation of the very limited innovation-active human resource base towards local research system collaboration. This raises the question of whether regional innovation policies are

excessively building on the narrow definition of a RIS, and as a result, fail in mobilizing and refining the broader industrial capabilities on which development ultimately depends (cf. Karlsen, Isaksen, & Spilling, 2011).

Figure 2-12 Local industrial collaboration by region. Proportions of active employment, ranked by performance in 2010-2012. *Finnmark is not reported due to strong period-to-period fluctuations and limited number of observations*



2.3 Summary of trends in the Norwegian regional landscape

During the period, the proportion of human resources that were mobilized into development work declined, thus weakening the micro-foundations for RIS construction. With a few notable region exceptions described below, the proportion of active employment occurring in firms with a local research system linkage also declined, in parallel with weakened local industrial networks and strengthened ties to national stronghold research institutions and international industrial networks.

Thus, as the VRI program strengthened its focus on mobilizing firms into research-based innovation and collaboration with local research institutions, the industrial base of Norway responded by reducing its overall emphasis on innovation and by strengthening linkages to industrial actors and research institutions outside their own regions.

This gives reason to question whether the strong emphasis of VRI on the narrow definition of RIS is counter-productive. It may alienate the broader population of firms by which research-based innovation generally and collaboration with research institutions particularly may be *perceived* to be of limited relevance, and thus fail in the most fundamental innovation policy objective that is mobilization into development work irrespective of specific mode. The strong emphasis of VRI on collaboration with *local* research system institutions may be exacerbating this problem, as regional colleges heavily burdened with educational duties may have limited capacity to directly engage with local industry, and limited research competences supportive of it. Incentives to engage with national stronghold institutions built into other programs and tools does not necessarily work towards reducing this problem. In the case of (small, regional) firms with limited R&D experiences and capacities, asymmetric power relationships and absorptive capacities may result in perceptions of particularly high risks and asymmetric learning beneficial foremost for the central institutions themselves.

Measured in terms of involved human resources, MLT manufacturing, LT manufacturing and ICTs remained throughout the period the largest innovation sectors. At the same time, the HT manufacturing, MHT manufacturing and ICT sectors exhibited a particularly strong commitment to development work. Notably, all these sectors emerge as skill-related with the Oil & Gas industry, and are to an extent that cannot be determined herein linked to this sector also through their value chains. The density of this skill-relatedness is reason to warn against the idea that growth in the services sector in general and ICTs in particular is independent of the manufacturing base and represent structural change away from it.

Generally, the largest contributors to innovation are also the largest contributors to local networks; as the most committed to innovation are the most committed also to local networking. One important exception is the ICT sector, which figure among the top-three in terms of contribution and commitment to development work, but emerges as detached, and increasingly so, from local (and domestic) collaboration networks. This is most striking in the VRI regions of Oslo & Akershus and Trøndelag where the contribution of this sector to local networks is far from reflecting its position as the largest and second largest contributor respectively to innovation-active employment. It reflects the two complementary notions of a 'dual' Norwegian economy that is one the one hand a 'systemic lock' between research institutions and the incumbent segment (Narula, 2002) that leaves non-incumbent industries with weak research system support, and on the other a mismatch between a distributed geography of innovation and centralisation of publicly funded research (Strand & Leydesdorff, 2013).

2.4 Inter-regional differentiation

General characteristic of the period considered is therefore 1) failure of Norwegian innovation policy to broadly mobilize the human resource base of the economy into development work; 2) globalisation combined with strengthened positions of incumbent sectors and national stronghold research institutions, at the expense of the local linkages that define a working regional innovation system; and 3) strong direct (i.e. demand drive) and indirect (i.e. skill-relatedness) influences on innovation activity

from the Oil & Gas sector. At the same time, the detailed region-by-region analyses presented in Chapter 3-18 demonstrate substantial inter-regional differences in industry composition, cross-fertilization through labour market mobility, micro-foundations for RIS construction and evolving system configurations. This diversity legitimizes the context-sensitive policy intervention advised by the RIS approach. Moreover, it means that the general answer the question of whether RIS have evolved in Norway during the period have limited policy and research interest compared to the different answers to the same question that differentiated regional dynamics and trends warrant.

Reflecting this, an attempt is below made to categorise the 15 VRI regions. This categorization is based on an overall judgement of trends in the different indicators for the different regions. Therefore, it is not precise; and many regions are borderline cases.

2.4.1 Networked regional innovation systems

This group comprises regions where strong and diverse micro-foundations for innovation system construction are reflected in the mobilisation of industry into local industrial (the broad definition) and research system (the narrow definition) collaboration.

In **Agder** (Chapter 3), strong performance in terms of innovation-active employment equals a strong foundation for the construction of RIS. This foundation is dominated by the manufacturing industries in general, and by MHT manufacturing in particular. Success in the construction of a 'regional networked innovation system' is indicated by consistent growth in local research system collaboration, dominated by the same skill-related core industries that also dominate local industrial collaboration *and* the local industrial structure as a whole. However, innovation activity in general and local research system collaboration in particular became more specialised during the period, that is, more dominated by a limited number of industries that as technology providers to the Oil & Gas industry are strongly dependent on growth impulses from it. This means that the danger over-specialisation is real, and that there is a need to strengthen the regional innovation system by broadening its sector and technology scope. Very strong concentration of international linkages is also reason for concern, as it suggests a certain inward-ness in the industrial base as a whole.

While **Trøndelag** (Chapter 15) exhibited lower than expected innovation activity levels at the beginning of the period, levels recovered to those that would be expected given the industrial composition of the region and national sector-level trends. Broad foundations for RIS construction are reflected in broadly distributed innovation activity, and materialize as local research system linkages that encompass a relatively wide range of industries. Thus, while levels of local research system collaboration decreased consistently during the period, they remained above the national average and co-existed with strong local industrial linkages. This and the diversity of these linkages point towards the existence of a networked regional innovation system combining STI and DUI-based modes.

2.4.2 Regionalized national innovation systems

This group comprises regions where weak trends in local collaboration are paralleled by strong performances or trends in collaboration with national stronghold research institutions.

By national standards, **Buskerud** (Chapter 4) was during the period a strong performer in terms of innovation-active employment, maintaining stable levels that were well above those expected given the industrial composition of the region and national sector-level trends. However, local collaboration levels fluctuated strongly, while the region consistently strengthened its linkages to non-local domestic research institutions and international networks. This indicates development towards a regionalized national innovation system more so than a networked regional innovation system.

During the period, **Møre & Romsdal** (Chapter 8) exhibited innovation activity levels below what would be expected given the composition of the regional economy and national sector-level trends. Local research system collaboration was strengthened substantially during the early years, after which it exhibited a downward trend. Local industrial collaboration declined consistently through each wave of

the CIS. Non-local research system collaboration, by contrast, was strengthened substantially, presumably reflecting the dependence of the regional industrial base on linkages to the national stronghold for maritime research in Trondheim City (VRI region Trøndelag). As the region underperforms in terms of global innovation network linkages, this is clearly indicative of development towards a regionalized national innovation system.

2.4.3 Specialised regional innovation networks

This group comprises regions where local networks are strong, yet specialised to the extent that they cannot be assumed to contribute to industrial dynamics based on variety. High levels of concentration and specialisation in local networks may on the one hand derive from highly specialised industrial structures, in which cases the scope for RIS construction is inherently limited. On the other, mismatches may be present between highly specialised local networks, and more diverse industrial structures that may or may not be reflected in diverse innovation activity. These cases indicate failure to capture the potential for RIS construction that is present in the local industrial base.

In the Oil & Gas stronghold of **Rogaland** (Chapter 11), innovation activity levels fluctuated around the national average, and the level exhibited by the region itself at the beginning of the period. Thus, there were no clear-cut general trends with respect to the micro-foundations for RIS, except increasing concentration in the wake of increasing direct contribution to innovation activity from the Oil & Gas sector. Reflecting this, local collaboration networks became during the period strongly dominated by this specific sector, and characterized also by a strong commitment of the much smaller Aquaculture industry. Still, overall levels of local collaboration fluctuated. Linkages to non-local domestic research system institutions and non-local industrial networks were particularly strong during the 2006-2008 period, which marked the beginning of a clear downward trend. Taken together, this combined with fluctuating local collaboration and weak two-way labour market linkages between Oil & Gas and the surrounding economy indicate development towards *specialised innovation networks* for the Oil & Gas and Aquaculture sectors. These networks exist within a larger VRI region where activities that fall outside these specific domains are provided with limited labour market and local network support.

In **Telemark** (Chapter 13), the large contribution and strong commitment of the MHT manufacturing sector to innovation activity must be understood against the background of the sharp increase in the commitment of the Oil & Gas sector to regional innovation. At the end of the period, these two densely skill-related sectors dominated local linkages. In parallel, the ICT and LT manufacturing sectors that were the third and fourth largest contributors of innovation-active employment reduced substantially their commitments to local research system collaboration and local industrial collaboration. As local research system linkages in spite of this were strengthened, and non-local domestic linkages fluctuated, this indicates development towards a specialised Oil & Gas technology innovation network *within* the region more so than an innovation system working in support of regional industries more generally.

The performance of **Nordland** (Chapter 9) is generally poor on all dimensions. The proportion of employment occurring in active firms decreased during the period, and what was already at the outset a substantial gap between expected and observed rates grew further. The proportion of active employment occurring in firms with a local research system linkage were consistently below the national averages, yet, recovered somewhat in 2010-2012. Local industrial collaboration consolidated at a level well below the national average, and the level exhibited by the region itself at the beginning of the period. Sector contributions and commitments to local networking fluctuated strongly. The exception to this is stable increases in the commitment of the Technical & Scientific Services sector to local industrial collaboration, and growing contributions from the Aquaculture industry to innovation activity that are mirrored in increasing sector contribution and commitment to local collaboration. These are early indications of development towards a specialised aquaculture innovation network that are particularly interesting in light of the reduced commitment of the industry to innovation and networking in other VRI regions.

Vestfold (Chapter 16) exhibited relatively stable levels of innovation-active employment distributed on a broad range of industrial sectors. Still, local networks are highly concentrated and dominated by the technology-intensive manufacturing industries that are both the largest contributors to these networks, and the most committed to them. This strong discrepancy between the concentration of innovation-active employment and the concentration of employment in firms with a local industrial and research system collaboration suggests that the region possesses a more diverse foundation for RIS construction than is currently exploited and point towards the consolidation of a specialized regional innovation network within what is otherwise a region where the potential for this to evolve into a networked regional innovation system comprising a broader range of industries is strong.

Through the period considered, innovation activity in the manufacturing-based VRI region of **Østfold** (Chapter 17) remained stable at a relatively high level. The region exhibits strong local collaboration networks, and local research collaboration that fluctuated around the (declining) national average. Innovation activity and collaboration networks exhibit exceptionally high concentration levels that match poorly a much more differentiated landscape of regional innovation. Interpreted against the background of weakened non-local domestic linkages and undetermined trends in international networking, this points towards the consolidation of a sector-specialised manufacturing innovation network more so than the emergence of a RIS. Yet, it also suggests, as in Vestfold, that there is potential for developing a working RIS if the broader innovation-active human resource base of the region is mobilized into active participation in local networks.

2.4.4 Weak RIS foundations or configurations

This group comprises regions with clear negative trends in terms of micro-foundations for RIS construction, or in terms of actual RIS configurations.

During the period considered, **Finnmark** (Chapter 5) reported innovation activity levels that were exceptionally low compared not only to national averages, but also compared to what would be expected given the industry structure of the region. Moreover, exceptionally high concentration levels and year-to-year fluctuations mean that the micro-foundations are fragile and dominated by a very limited number of firms and industrial sectors. Due to the low number of observations on which innovation statistics are based, the data must be interpreted with extreme caution and the full analysis of activity and linkages cannot be reported due to data disclosure rules.

In **Hedmark & Oppland** (Chapter 6), innovation-active employment declined to levels well below those initially exhibited, and even those that would be expected given the low-tech and agriculture-dominated industrial base of the region. Fluctuating local research system collaboration and weakening local industrial collaboration is contrary to what would be expected if a RIS configuration was emerging. This and the strong concentration of innovation-active employment underscores that a main challenge in the region is broader mobilisation of firms and industries into development work. At the same time, the region has managed to mobilize the small Technical and Scientific Services and ICT industries into strengthening their commitment to local research system collaboration. Both industries are also committed to local industrial collaboration, and relatively strongly skill-related with each other. This does point towards the emergence of an ICT and Technical & Scientific Services network *within* a larger VRI region where RIS foundations and configurations are generally weak.

Troms (Chapter 14) exhibited weak employment growth during the period, and had the lowest capacity of all regions to mobilize human resources into development work. Compared to the national average, local industrial and research system collaboration fluctuated strongly, the latter around a very high level. International research system linkages that were at the outset weak were strengthened. In spite of its small size, the ICT sector was one of the largest contributors of innovation-active employment and employment with a local linkage. While this to a large extent reflects the inability of the region to mobilize for innovation on a broader basis, it is still notable because it contradicts the national trend of decreasing contributions and commitments from ICTs to local collaboration. Beyond this, regional networks are strongly dominated by the LT manufacturing sector. The relatively large Oil

& Gas sector of the region not among the most committed to regional innovation in general, or to networked innovation in particular.

2.4.5 Undetermined development trends

Hordaland (Chapter 7) exhibited strong employment performance in a relatively broad range of industries that emerge as strongly skill-related with each other. Still, there are no clear-cut trends in key RIS indicators for the period as a whole. The mobilisation of firms into development work that is the micro-foundation for RIS construction fluctuated throughout the period; as did the proportion of innovation active employment involved in local research system collaboration and local industrial collaboration. A more clear-cut negative trend for international collaboration is evident for the period as a whole. When interpreted against the background of broad micro-foundations for RIS construction, this suggest that there is potential that has not been captured.

Oslo & Akershus (Chapter 10) exhibited strong innovation activity levels that weakened during the two last stages of the period, and low, stable levels of collaboration at all spatial scales. This highly notable, given that the region hosts the largest university, in addition to university colleges, business schools and research institutes. The contribution and commitment of the ICT sector to local industrial and research system collaboration declined substantially, in spite of this sector remaining the *largest* single contributor of innovation-active employment in region (accounting for almost a third) and the presence of a broad range of high-quality research institutions. Taken together, this suggests that no type of type of RIS-configuration that is defined by the nature, geography and strength of collaborative ties has insofar been built on the strong and broad foundations for this that exist in the Capital region.

In **Sogn & Fjordane** (Chapter 12), weak micro-foundations for RIS construction, fluctuating (research system) or declining (industrial) collaboration and strengthened non-local domestic ties suggests that developed is in the direction of a regionalized national innovation system configuration. However, this cannot be determined with certainty.

3 Agder

3.1 Region overview

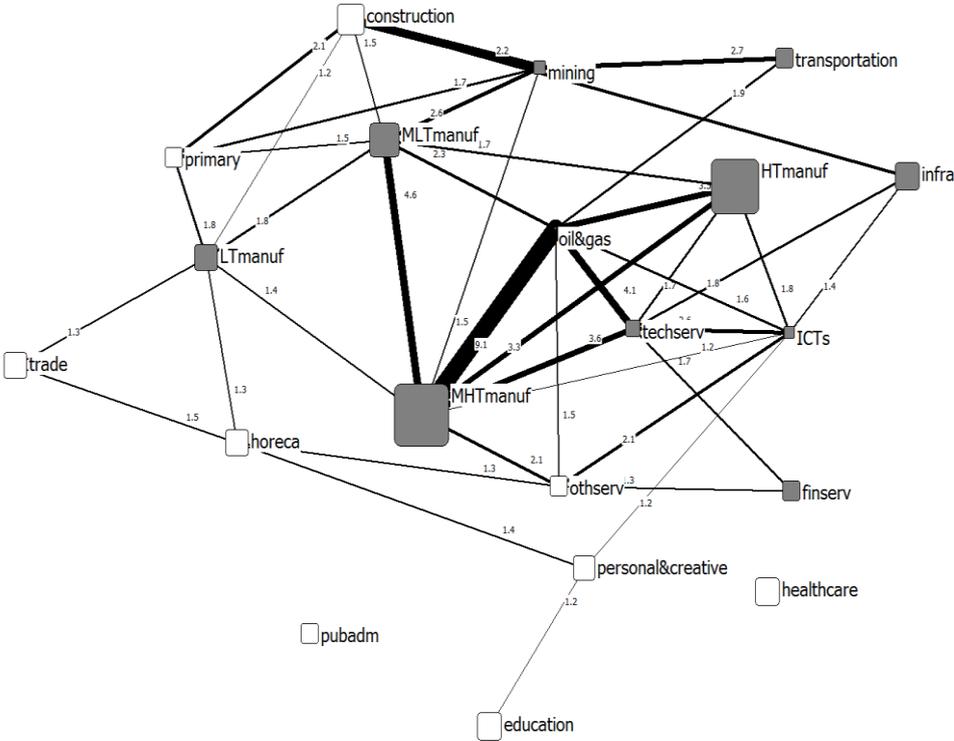
The VRI region of Agder accounted for approximately 5 per cent of Norwegian employment (Table 3-1, bottom row). During the period, it strengthened its specialisation in technology-intensive manufacturing industries, and exhibited particularly strong employment growth in the MHT manufacturing industry that include equipment suppliers to the Oil & Gas industry. Exceptional growth rates in the Oil & Gas sector itself must be understood against the background of limited regional employment in this sector at the beginning of the period.

Table 3-1 Location quotients & growth rates, Agder. Sectors fully covered by the harmonized CIS sample are in grey. Location quotients > 1 are in bold.

	Location quotients				Employment growth
	2006	2008	2010	2012	2006-2012
Primary	0,82	0,78	0,71	0,79	-19,70 %
Mining & Quarrying	0,71	0,62	0,61	0,56	-4,17 %
Oil & Gas	0,02	0,31	0,19	0,19	(2172 %)
HT manufacturing	1,94	2,00	1,93	2,03	-4,18 %
MHT manufacturing	1,52	2,01	2,30	2,33	57,65 %
MLT manufacturing	1,43	1,33	1,39	1,34	-12,52 %
LT manufacturing	1,13	1,11	1,05	1,05	-18,07 %
Infrastructure	0,95	1,02	1,05	1,08	31,45 %
Construction	1,15	1,19	1,22	1,22	25,17 %
Trade	1,01	1,01	1,04	1,02	3,52 %
Transportation	0,92	0,86	0,81	0,82	-10,21 %
Horeca	1,04	1,07	1,05	1,06	8,81 %
ICTs	0,56	0,58	0,56	0,50	2,97 %
Financial Services	0,78	0,77	0,78	0,80	9,08 %
Technical & Scientific services	0,73	0,71	0,70	0,71	24,45 %
Other services	0,97	0,93	0,91	0,83	-2,96 %
Public administration	0,82	0,82	0,80	0,81	15,25 %
Education	1,08	1,08	1,07	1,09	10,31 %
Healthcare	1,04	1,05	1,07	1,09	16,41 %
Personal & Creative	0,93	0,92	0,92	0,96	17,62 %
Proportion of domestic employment & regional employment growth	5,22 %	5,32 %	5,27 %	5,24 %	8,84 %

Data on local labour market mobility reveal strong movements within a cluster comprised of the Oil & Gas, manufacturing, technical services and ICT technical services sectors. Revealed skill-relatedness is particularly strong between Oil & Gas and MHT manufacturing, between MHT manufacturing and MLT manufacturing, and, notably, between the Technical and Scientific Services sector and Oil & Gas. Still, also exchanges of employees between Oil & Gas and HT manufacturing are well above what would be expected if mobility flows were evenly distributed. The LT manufacturing sector has a more peripheral position and exhibit relatively strong skill-relatedness with the primary sector (agriculture, forestry, fisheries & aquaculture). This suggests that it benefits comparatively less from the intense knowledge flows that defines the main cluster of skill-related industries in Agder.

Figure 3-1 Skill-relatedness revealed by local labour market mobility in Agder, 2002-2012. Line thickness expresses the ratio of observed local mobility over expected mobility, i.e. the degree of revealed skill relatedness. Node size signifies location quotients. Grey nodes are sectors included in the innovation analysis. Only linkages where observed/expected > 1.1 are depicted



3.2 Baseline innovation profile

The first line in Table 3-1 below gives the number of establishments in the sample, i.e. the number of establishment in Agder that belong to enterprises sampled by the CIS. The second line gives the number of establishment that the sample represents, i.e. the population size estimated based on sampling weights provided by Statistics Norway.

Table 3-2 Number of observations (establishments)

	CIS2006	CIS2008	CIS2010	CIS2012
Unweighted (sample)	563	514	531	549
Weighted (population)	1123,149	1062,61	971,7691	1024,709

Figure 3-1 and 3-2 describes key innovation activity and collaboration characteristics. In contrast to the national trend, the proportion of employment occurring in innovation-active firms remained stable and therefore increased relative to the declining national averages. The growth in local research system collaboration has been exceptionally strong and compared to the national average, and to the region itself. Innovation collaboration at higher geographical levels, i.e. non-local domestic and international, is characterized by fluctuations between the different waves of the CIS and thus by the absence of clear trends. Still, it is notable that the strength of global 'pipelines' during peak years is well above the average for Norway as a whole.

Figure 3-2 Innovation profile Agder, relative to Norway = 1

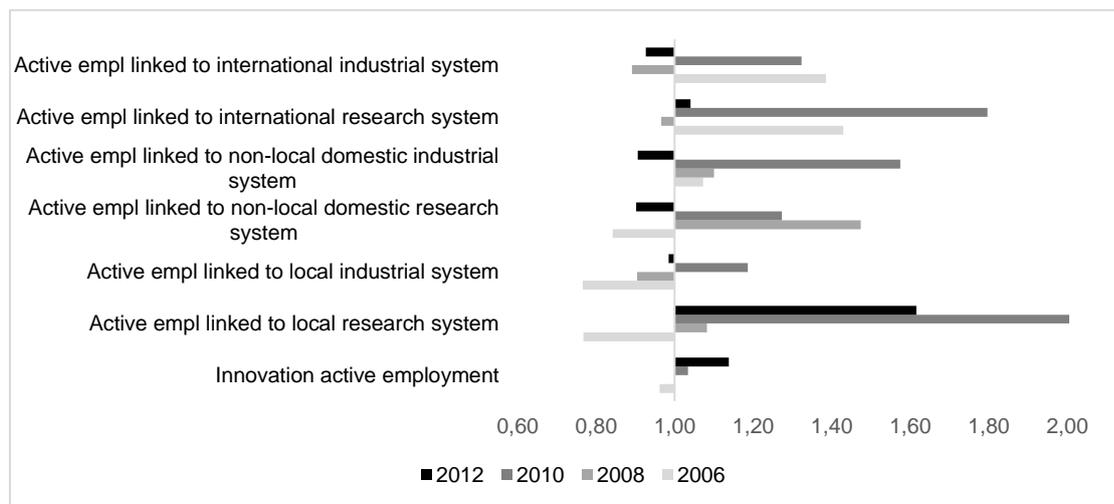
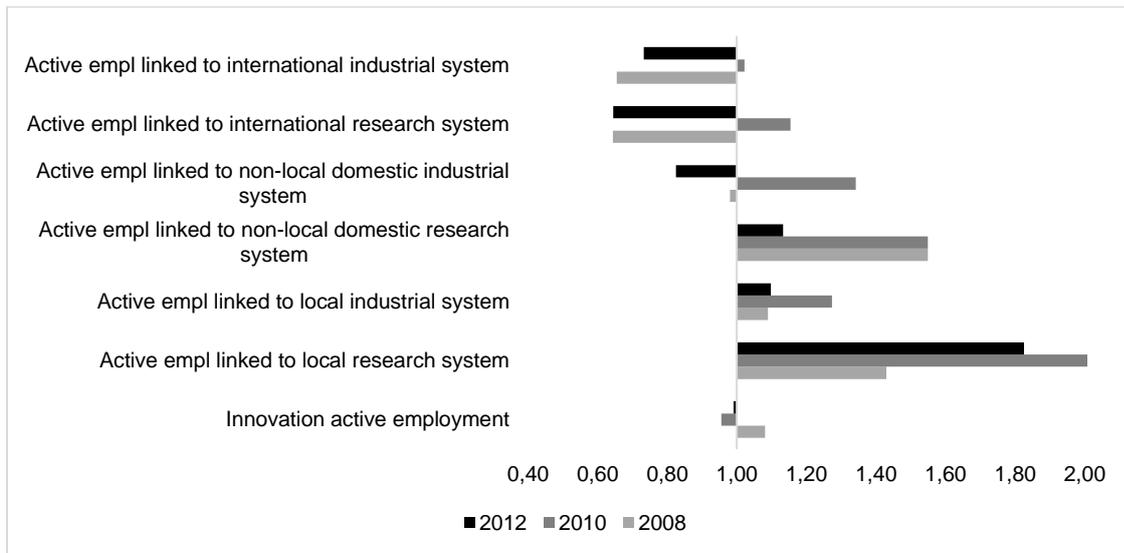


Figure 3-3 Innovation profile Agder, relative to region in 2006 = 1



3.3 The micro-foundations of RIS

Figure 3-3 below describes how innovation activity has evolved in Agder. At the beginning of the period, observed innovation activity in the region was below what would be expected given the composition of CIS employment and national averages for the different industrial sectors. At the end of the period, observed innovation activity was equal to what would be expected given national sector-level trends. Consequently, the micro-foundations for RIS were strengthened during the period.

Figure 3-4 Observed vs. expected innovation activity in Agder

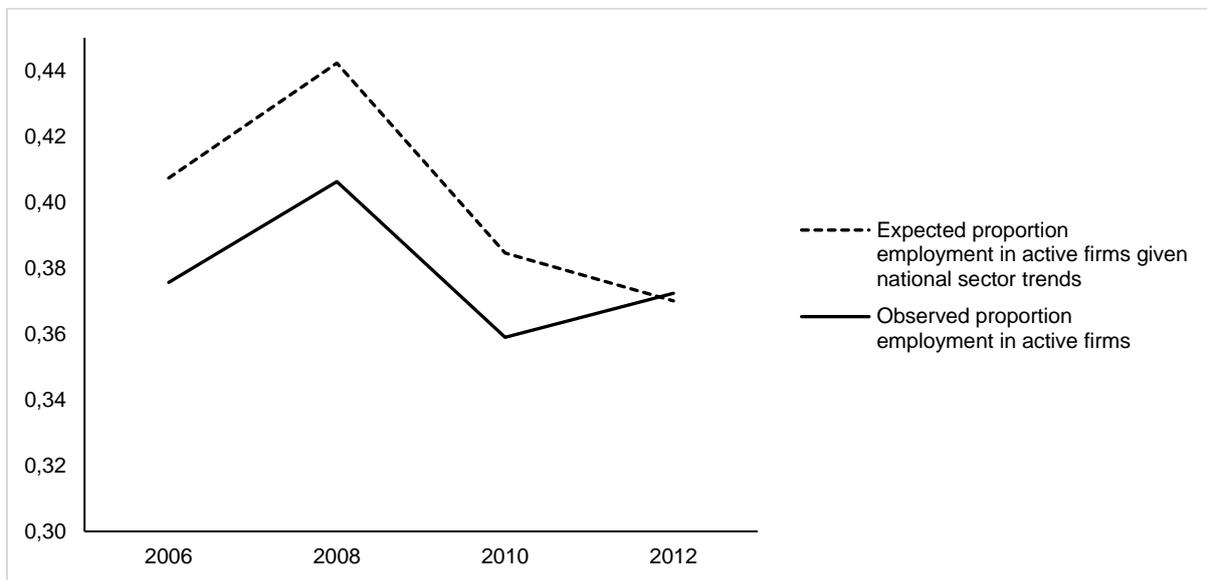


Figure 3-5 depicts Herfindahls index scores for employment concentration. It shows that the concentration of employment captured by the various waves of the CIS decreased marginally during the period, while the concentration of active employment increased marginally. The growing gap between the concentration of overall employment and concentration of active employment suggests that there is room for broader regional mobilization into development work.

Figure 3-5 Concentration of innovation active employment in Agder. Herfindahls index

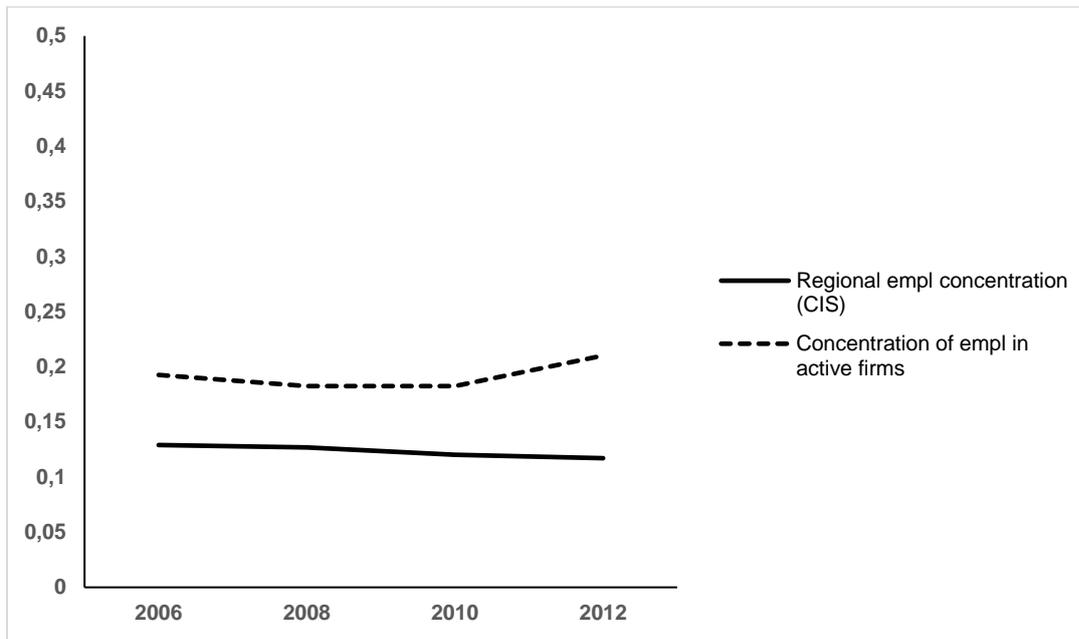
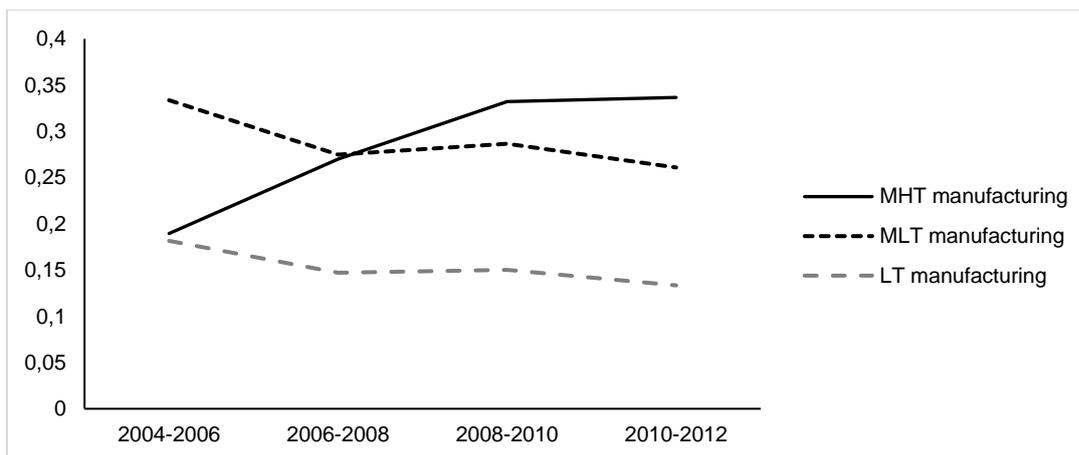


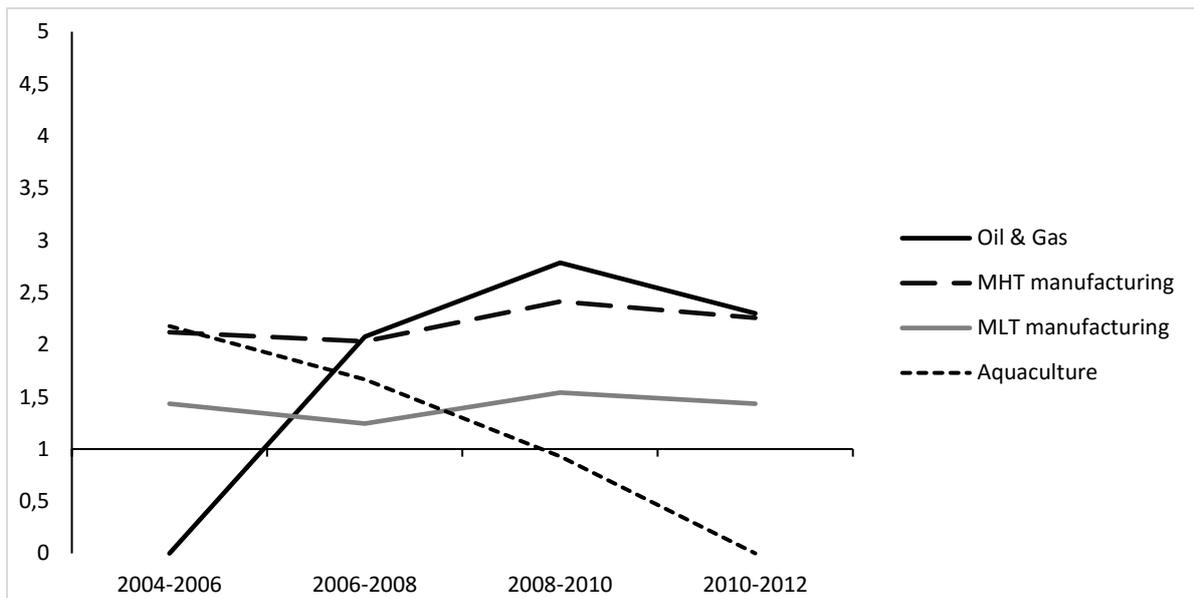
Figure 3-6 depicts how the proportions of innovation-active employment accounted for by the three largest sectors have developed. It suggests that beneath the marginal overall increase in concentration of innovation-active employment lies a strong increase in the proportion accounted for by the MHT manufacturing sector. This sector, which include suppliers of advanced offshore oil & gas equipment, accounted at the end of the period for 34 per cent of innovation-active employment. Conversely, the relative contributions from MLT manufacturing and LT manufacturing decreased, leaving the proportion accounted for by the three largest combined relatively stable at 70 per cent at the beginning of the period and 73 per cent at the end of it.

Figure 3-6 Sector contribution of innovation-active employment in Agder. The three largest at the beginning and end of the period.



As is evident from Figure 3-7 below, MHT and MLT manufacturing are also among the top three sectors measured in terms of commitment to innovation, i.e. in terms of active employment relative to all employment contributed by the sectors. This commitment has remained stable during the period. The local aquaculture industry substantially reduced its commitment to innovation, while the Oil & Gas industry increased it. Both trends are consistent from each CIS round to the next. This reflects how the region during the period established itself as a stronghold for the development and manufacture of advanced solutions for the offshore Oil & Gas industry.

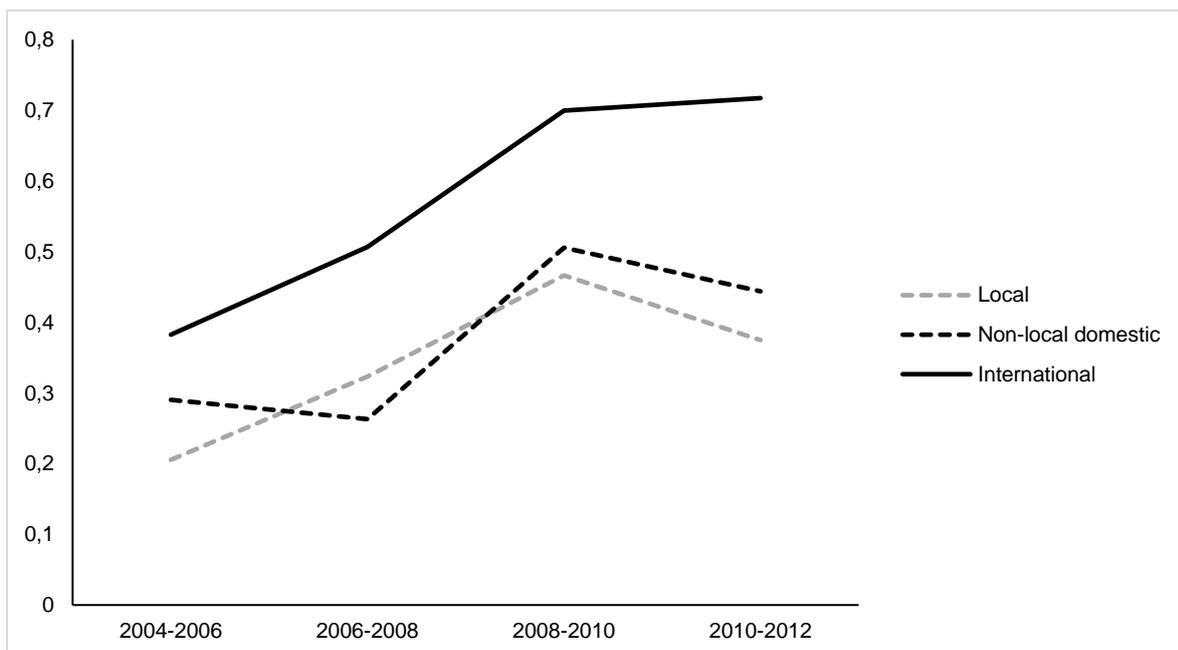
Figure 3-7 Sector commitment to innovation activity in Agder. The three most committed at the beginning and end of the period.



3.4 The narrow definition of RIS: Local research system linkages

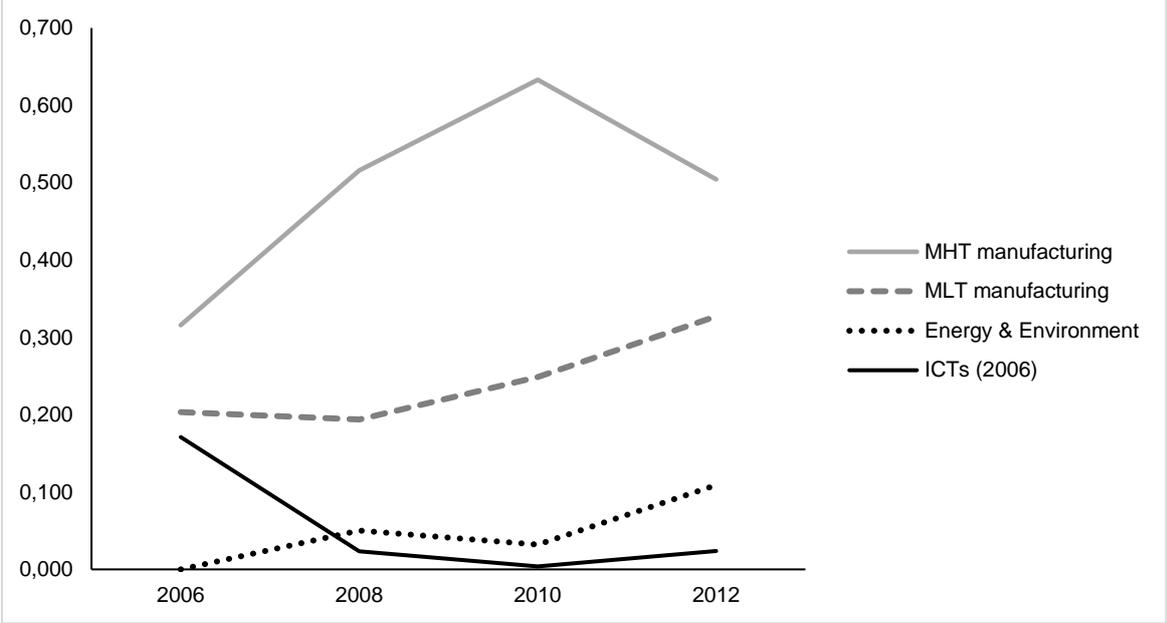
The narrow definition of a RIS emphasizes the strength and diversity of local university industry linkages. From Figure 3-8, it is evident that these linkages have become highly concentrated during the period, with a limited number of sector dominating collaboration at all geographical scales and concentration levels being highest at the international level. This suggests that there is room for broadening these networks.

Figure 3-8 Sector concentration of research system collaboration at different geographical scales in Agder



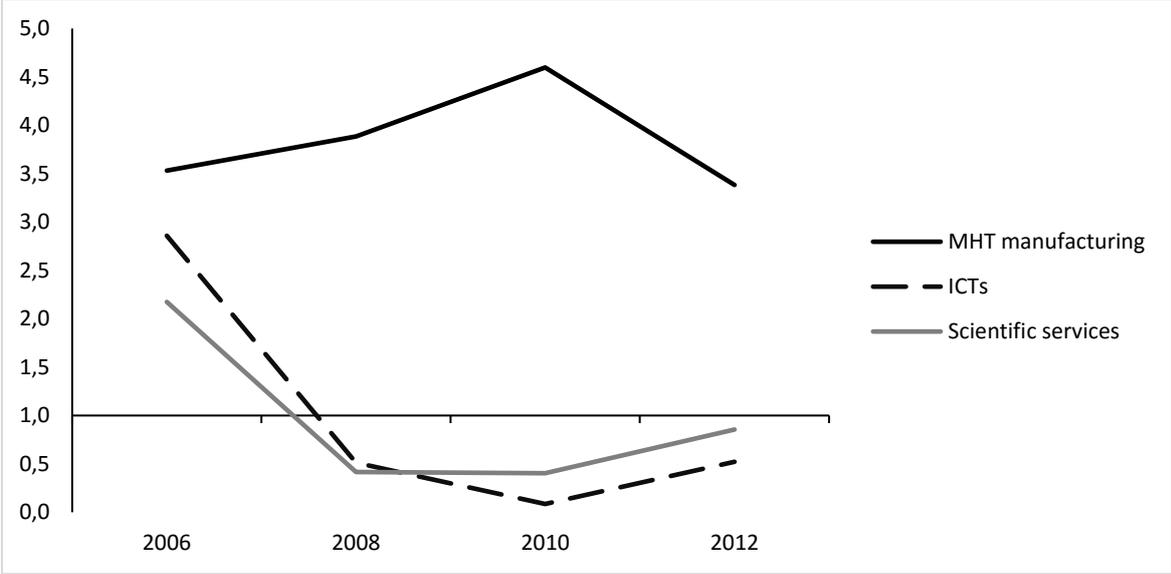
Mirroring the overall contribution and commitment of this sector to regional innovation, local research system linkages are dominated by the MHT manufacturing sector that at the end of the period accounted for 50 per cent of this activity (up from 30 per cent at the beginning). The MLT manufacturing sector also strengthened its contribution to local research system collaboration, while the Energy & Environment sector entered such networks during the period and grew to become one of the three largest contributors. Reflecting the national trend already identified, the ICT sector reduced its contribution from 17 per cent at the beginning of the period to just above 2 per cent at the end of it.

Figure 3-9 Sector contribution to local research system collaboration in Agder. The three largest during the whole period.



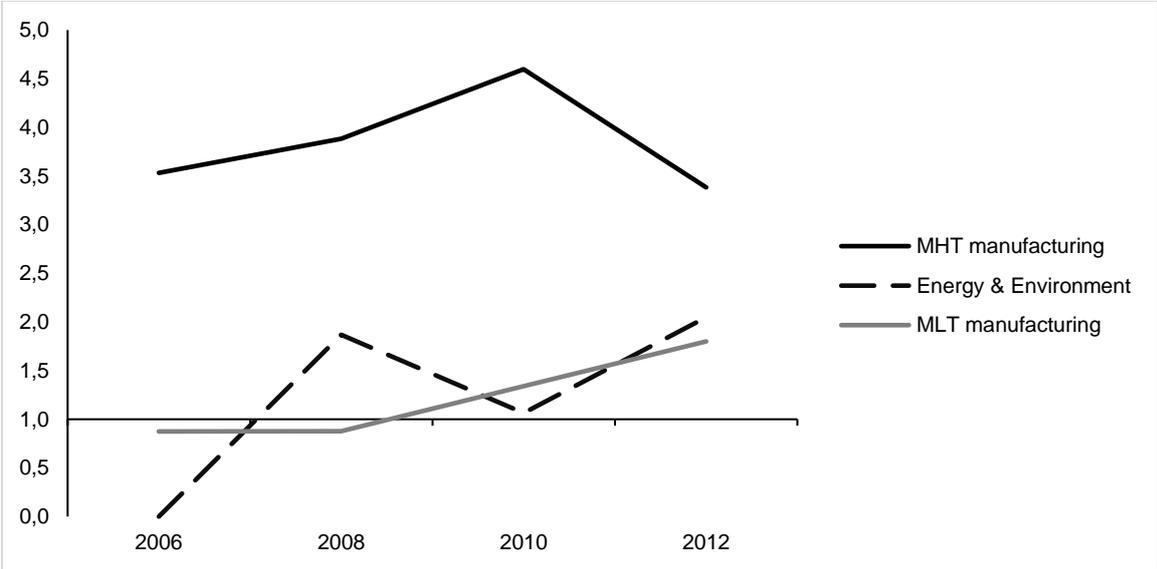
The ICT sector also substantially reduced its commitment to local research system collaboration during the period, meaning that consistently decreasing contribution levels cannot be attributed to reductions in the overall size of the sector. Instead, they indicate that ICTs have withdrawn from interaction with local research system institutions. A strong and consistent reduction in commitment is also detected from the comparatively smaller Technical & Scientific Services sector, which at the beginning of the period ranked as the third most committed.

Figure 3-10 Sector commitment to local research system collaboration. *The three most committed in at the beginning of the period.*



Of the three most committed sectors at the beginning of the period, only MHT manufacturing is among the three most committed at the end of it. Taking the positions initially held by the ICT and Scientific Services sectors were the MLT manufacturing and Energy & Environment sectors, which at the end of the period accounted for around 2 times more employment with a local research system linkage than would be expected from their size, i.e. contribution of innovation-active employment.

Figure 3-11 Sector commitment to local research system collaboration in Agder. *The three most committed in at the end of the period (2010-2012)*

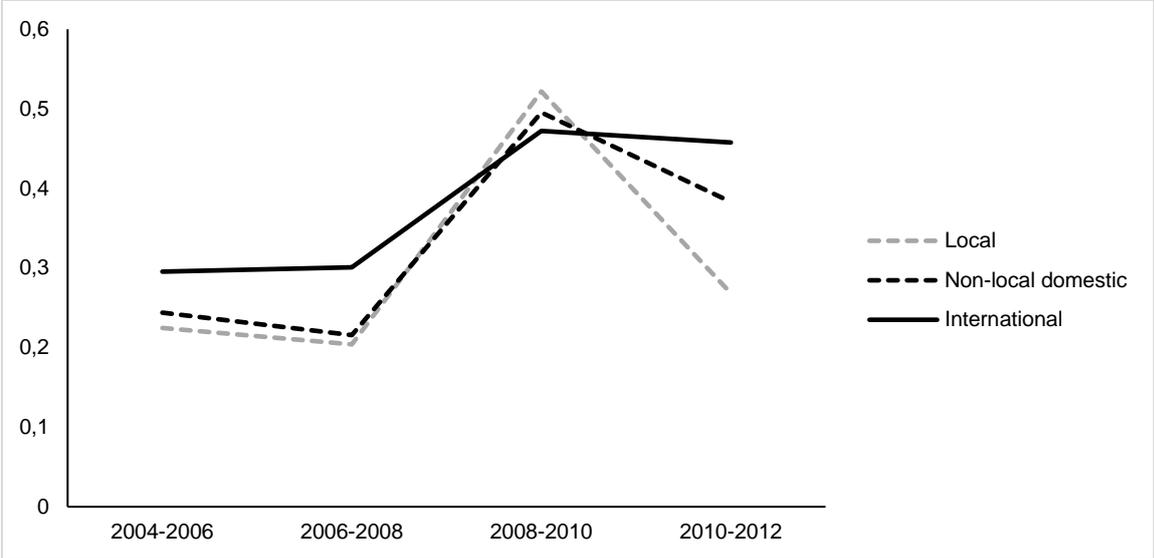


3.5 The broad definition of RIS: Local inter-firm linkages

Figure 3-12 describes the concentration of industrial networks. At the local and domestic level, strong increases in concentration during the years 2006-2010 were followed by decreasing concentration in 2010-2012. This was most notable at the local level, where concentration scores at the end of the period were roughly comparable to those at the beginning. Non-local and international industrial

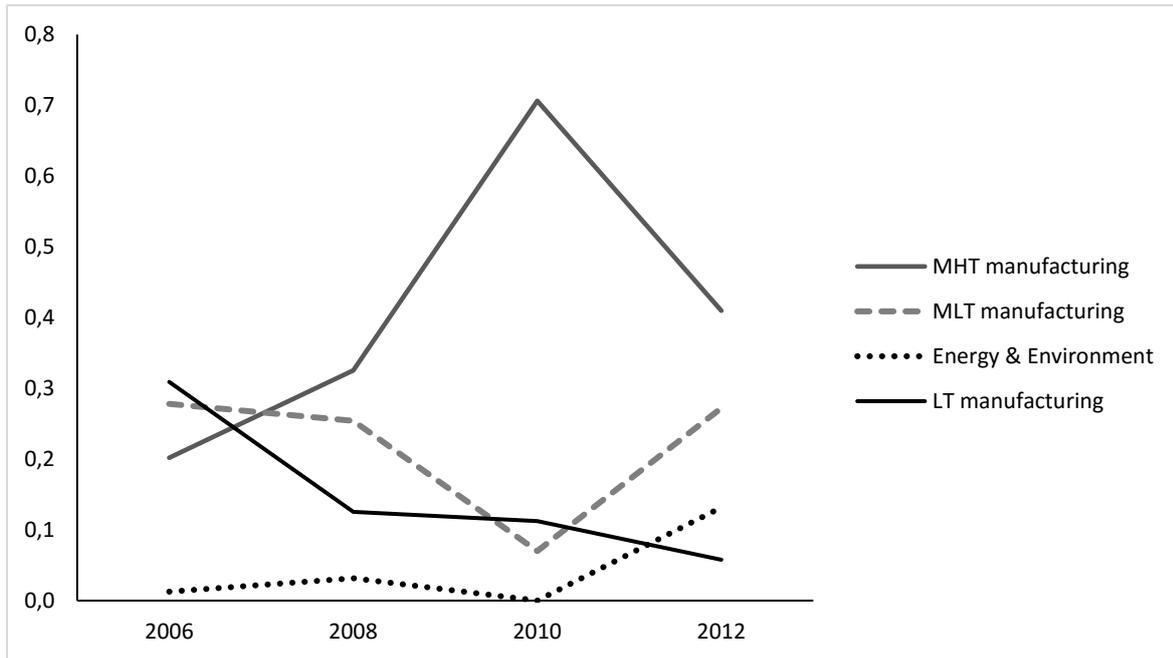
collaboration was at the end of the period substantially more concentrated on certain sectors than at the beginning. This is reason for concern if it implies that the region maintains narrower contact points to non-local networks.

Figure 3-12 Sector concentration of industrial collaboration at different spatial scales in Agder



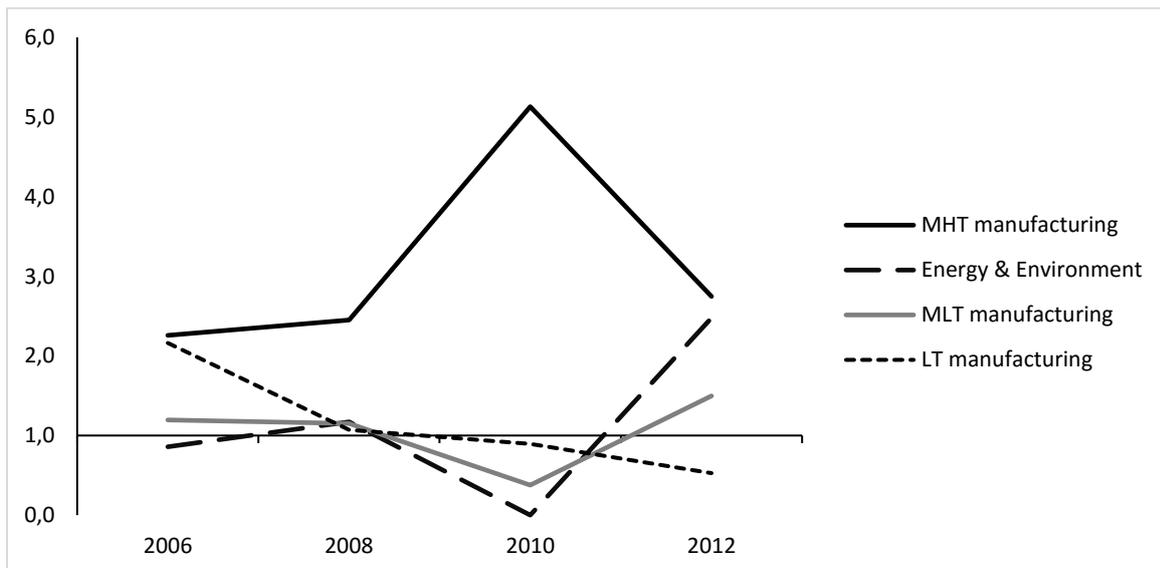
From Figure 3-13 below, it is evident that local industrial collaboration is dominated by the same MHT and MLT manufacturing sectors that also dominate local research system linkages; and that the peak in concentration during the years 2008-2010 is attributable to a particularly strong contribution from the MHT manufacturing sector to local and non-local industrial collaboration this period. The position of LT manufacturing among the top three contributors was during the period overtaken by the Energy & Environment sector, which is also strengthening its linkages to the local research system. This is notable, because it suggests that local industrial and research system networks are overlapping and represent venues research-based and experience-based knowledge complement each other in the innovation processes of dominant industries.

Figure 3-13 Sector contribution to local industrial collaboration. *The three largest during the whole period*



The Energy & Environment sector has substantially increased its commitment to local industrial networks, accounting at the end period for 2.4 times as much as would be expected from its overall contribution to innovation-active employment in Agder. Similarly, the LT manufacturing sector decreased its commitment to local industrial collaboration from 2.2 to 0.57, that is, only 57 per cent of what would be expected given its size. The commitment of MHT manufacturing has remained stable at high levels, with the exception of a peak in 2008-2010 where it accounted for five times as much as would be expected from its size.

Figure 3-14 Sector commitment to local industrial collaboration in Agder. The three largest during the whole period. *Note: One strongly committed sector is not reported due to data disclosure reasons.*



3.6 Summary

During the period considered, Agder exhibited strong employment growth and strengthened its specialisation in skill-related technology-intensive manufacturing industries. Growth was strong also in the Technical and Scientific Services industry, which is interlinked with the manufacturing domain through the labour market.

Strong performance in terms of innovation-active employment equals strong foundations for the construction of RIS. In addition, the relatively small Oil & Gas industry of the region exhibit a strong increase in commitment to local innovation, while the aquaculture industry reduced its commitment substantially during the period.

Success in the construction of a 'regional networked innovation system' is indicated by particularly strong local research system collaboration, dominated by the same skill-related core industries that also dominate local industrial collaboration *and* the local industrial structure as a whole. At the same time, the aquaculture sector reduced its commitment to local innovation in general while the ICT sector and the Technical & Scientific Services sectors substantially reduced their commitments specifically to local research system collaboration. As a result, innovation activity in general and local research system collaboration in particular has become more specialised, that is, more dominated by a limited number of industries that presumably are strongly dependent on growth impulses from the Oil & Gas industry.

While this reflects an industrial structure that is specialised at the outset, it suggests that there is a need for broadening the scope of the regional innovation system and loosen its lock-in to the Oil & Gas sector. Finally, strong concentration of international linkages is reason for concern.

4 Buskerud

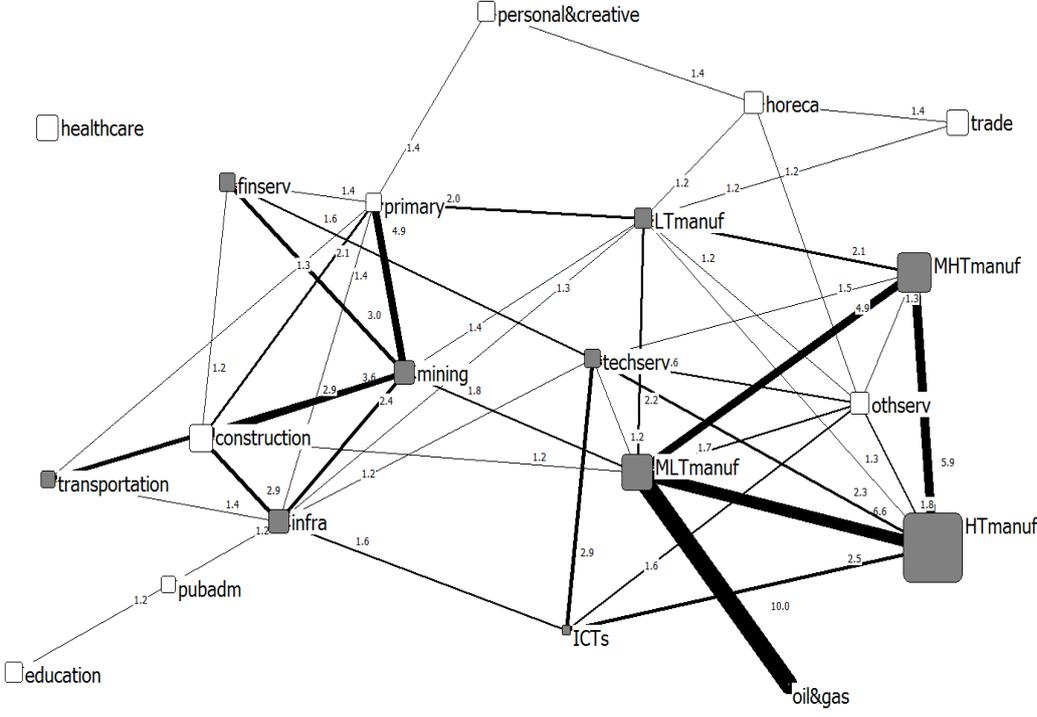
4.1 Region overview

The VRI region of Buskerud account for just below 5 per cent of Norwegian employment, and experienced a strong 9.5 per cent employment growth during the period considered. In terms of industry composition, the most notable feature is strong specialisation and growth in manufacturing, except low-tech manufacturing where employment declined markedly, and limited employment in the Oil & Gas industry group that comprises firms directly engaged in extraction of these resources.

Table 4-1 Location quotients & employment growth by sector, Buskerud. Sectors marked with grey are included in the harmonized CIS sample.

	Location quotients				Employment growth
	2006	2008	2010	2012	2006-2012
Primary	0,80	0,78	0,81	0,80	-16,19 %
Mining & Quarrying	0,95	1,05	1,04	1,07	37,99 %
Oil & Gas	0,00	0,02	0,00	0,01	233,33 %
HT manufacturing	2,81	2,97	2,98	3,34	9,50 %
MHT manufacturing	1,83	1,83	1,80	1,89	6,13 %
MLT manufacturing	1,33	1,41	1,54	1,66	16,97 %
LT manufacturing	1,03	0,94	0,90	0,86	-25,67 %
Infrastructure	0,95	0,96	0,99	1,02	25,24 %
Construction	1,20	1,19	1,24	1,24	24,09 %
Trade	1,11	1,13	1,12	1,11	4,18 %
Transportation	0,78	0,78	0,75	0,75	-2,09 %
Horeca	1,04	1,01	1,03	0,99	2,90 %
ICTs	0,40	0,42	0,42	0,38	10,12 %
Financial Services	0,76	0,76	0,77	0,76	6,68 %
Technical & Scientific services	0,87	0,83	0,84	0,84	23,04 %
Other services	1,01	1,04	1,03	0,98	10,48 %
Public administration	0,73	0,74	0,71	0,70	12,06 %
Education	0,86	0,85	0,86	0,87	11,63 %
Healthcare	1,10	1,10	1,11	1,12	13,70 %
Personal & Creative	0,91	0,91	0,94	0,91	15,19 %
Proportion of domestic employment & regional employment growth	4,82 %	4,86 %	4,87 %	4,87 %	9,50 %

Figure 4-1 Skill-relatedness revealed by local labour market mobility in Buskerud, 2002-2012. Line thickness expresses the ratio of observed local mobility over expected mobility, i.e. the degree of revealed skill relatedness. Node size signifies location quotients. Grey nodes are sectors included in the innovation analysis. Only linkages where observed/expected > 1.1 are depicted



From Figure 4-1, it is evident that local mobility flows during the period indicate strong preferences for mobility within a cluster comprised of HT, MHT and MLT manufacturing. While small, the Oil & Gas sector is linked to this cluster through strong skill-relatedness with the MLT manufacturing sector that is a technology provider to it. Scientific & technical services, and ICTs, are also relatively small sectors that are interlinked with the skill-relatedness cluster dominated by manufacturing firms. A second distinct cluster is comprised of the relatively large mining sector, construction, infrastructure and primary industries such as agriculture & forestry.

4.2 Baseline innovation profile

The first line in Table 4-2 below gives the number of establishments in Buskerud that belong to enterprises sampled by the CIS. The second line gives the number of establishment that those sampled are meant to represent, i.e. the population size estimated based on sampling weights provided by Statistics Norway.

Table 4-2 Number of observations (establishments)

	CIS2006	CIS2008	CIS2010	CIS2012
Unweighted (sample)	456	439	463	453
Weighted (population)	1048,202	945,221	958,5108	893,5144

Figure 4-2 and 4-3 describes key development trends. The level of innovation activity has been stable compared to the region itself, and increasing compared to the declining national average. Relative to the country, the performance of Buskerud is strong also in terms of international innovation collaboration. Local collaboration, by contrast, fluctuated strongly, while non-local domestic research system linkages were strengthened compared both to the region itself at the beginning of the period and to the evolving national averages. This is a clear indication of development towards a regionalized national innovation system.

Figure 4-2 Innovation profile Buskerud, relative to Norway = 1

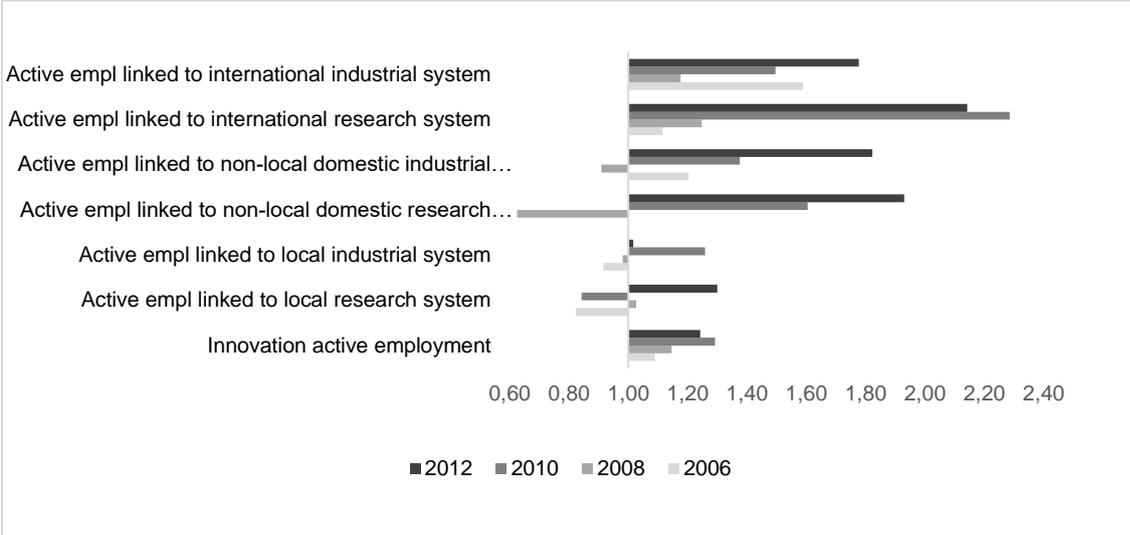
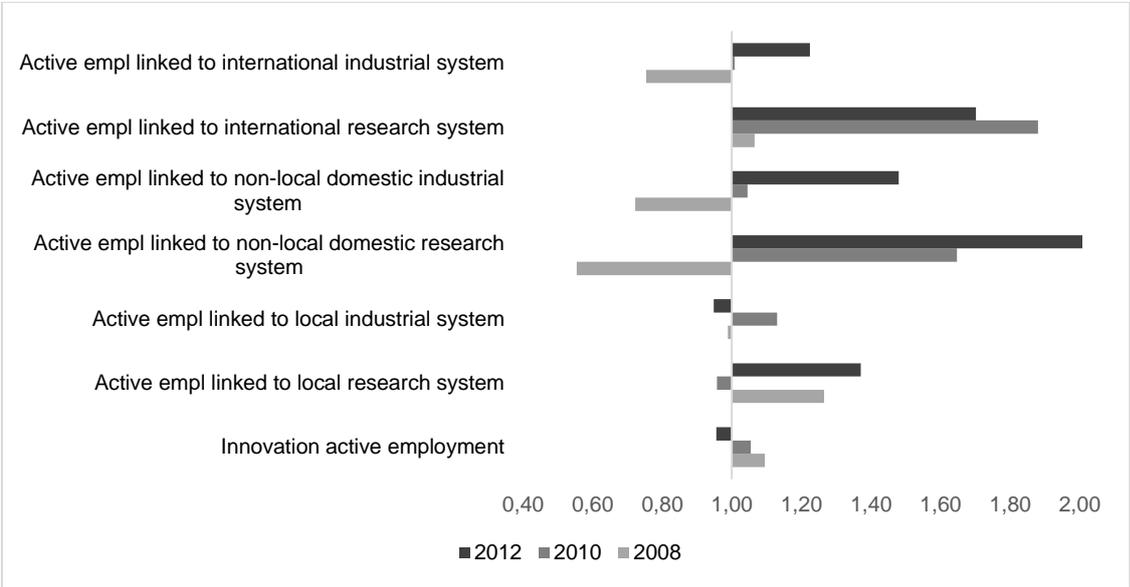


Figure 4-3 Innovation profile Buskerud, relative to region in 2006 = 1



4.3 The micro-foundations for RIS

From Figure 4-3, it is evident that Buskerud exhibit innovation activity levels well above what would be expected given national sector averages and the structural composition of the region itself. Still, as of 2006-2008, observed levels have been declining, but less so than would be expected given national

trends. This means that the micro-foundations for regional innovation systems are very strong compared to the national average.

Figure 4-4 Observed vs. expected innovation activity in Buskerud

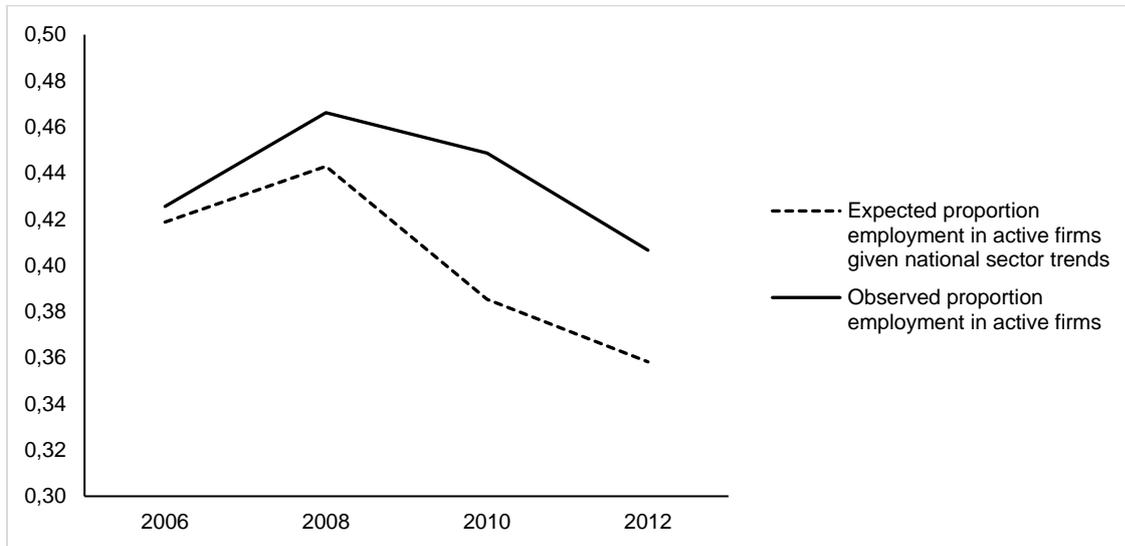
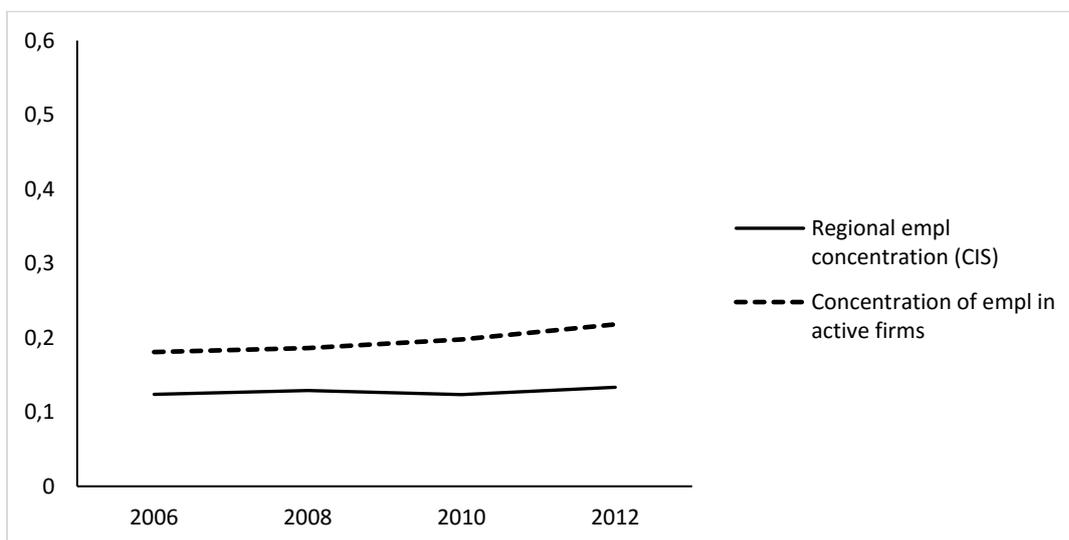


Figure 4-4 shows that the region exhibit relatively low and only slightly increasing concentration of innovation active employment. At the same time, the concentration of all regional employment captured by the CIS remained stable. Thus, as in many other VRI regions, the gap between diversity in the regional employment base and diversity in the regional knowledge base that is innovation active employment is increasing.

Figure 4-5 Concentration of innovation active employment in Buskerud. Herfindahls index



Throughout the period, the largest contributor of innovation-active employment was the MLT manufacturing sector, which accounted for 31 per cent and 38 per cent of active employment at the beginning and end of the period, respectively. MHT manufacturing increased its share from 14 per cent to 21 per cent, while HT manufacturing remained stable at levels around 12 per cent. Consequently, while the three largest sectors at the beginning of the period accounted for 58 per cent of innovation-active employment, they accounted at the end for as much as 71 per cent. Notably, these are all manufacturing sectors in the upper part of OECDs technology intensity classification.

Figure 4-6 Sector contribution to innovation-active employment in Buskerud. The three largest during the period.

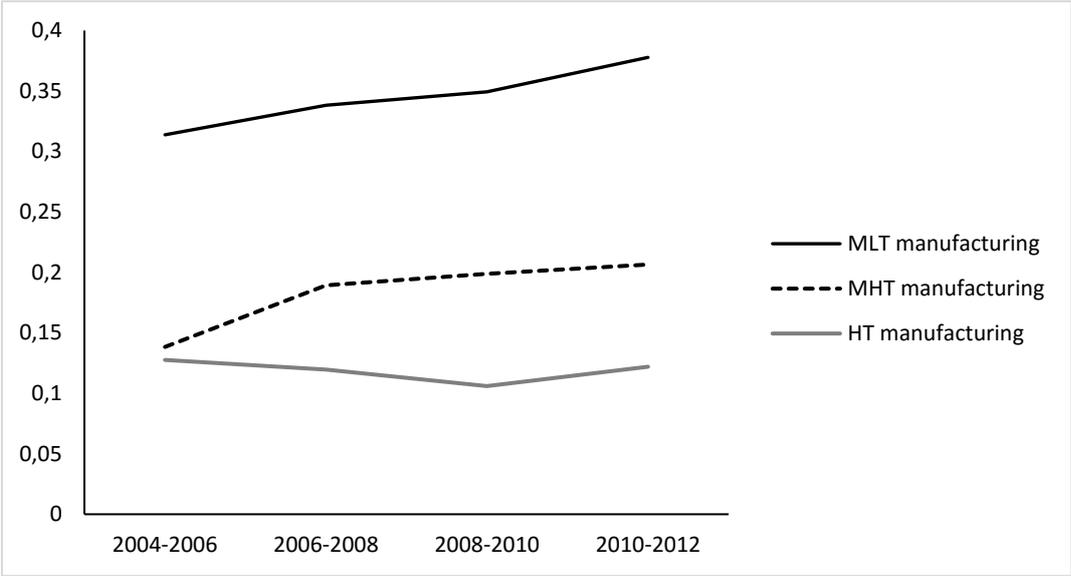
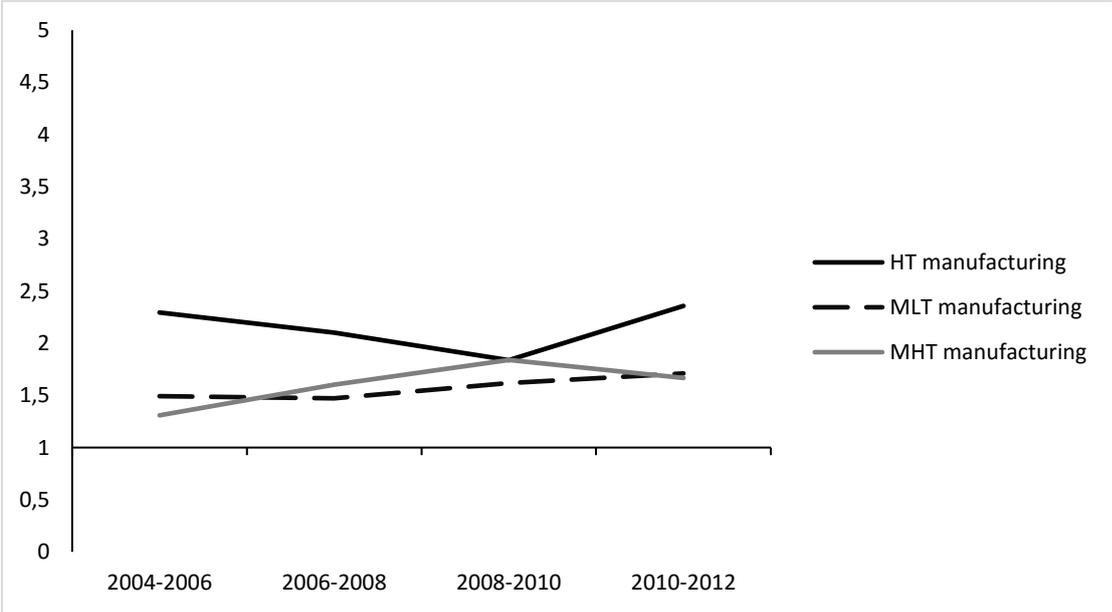


Figure 4-6 below shows that the largest contributors of innovation-active employment in the region are also the sectors that are most committed to innovation, and that this commitment is stable yet somewhat higher at the end of the period.

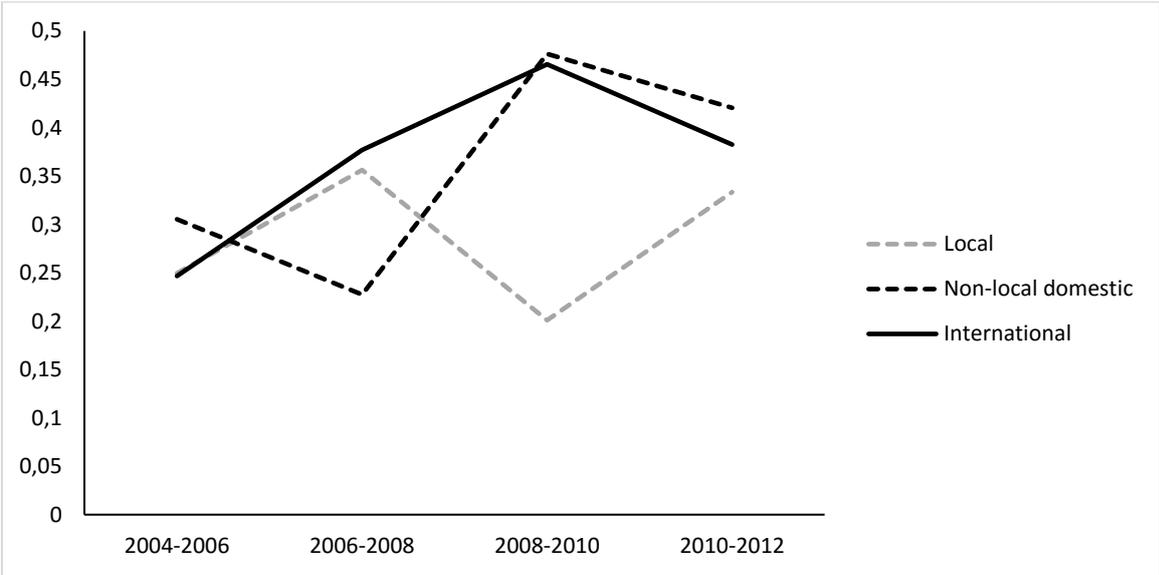
Figure 4-7 Sector commitment to innovation activity. The three largest during the period.



4.4 The narrow definition of RIS: Local research system linkages

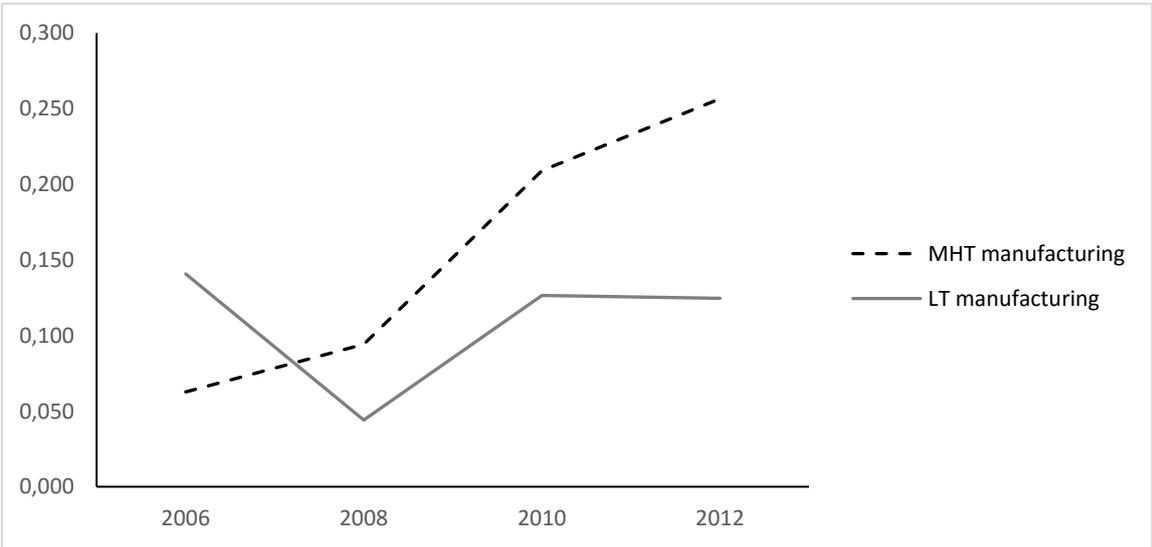
A clear trend in the region is that international research system linkages have become more concentrated during the period. A less clear-cut trend is increasing concentration also of non-local domestic research system linkages. The concentration of local linkages has fluctuated between relatively low and moderate levels.

Figure 4-8 Sector concentration of research system collaboration in Buskerud



Fluctuations in concentration scores are partly driven by the entry and exit of one specific sector, which is comprised of a limited number of firms. The identify of this sector and data on variations in its contribution to local research system collaboration cannot be reported due to data disclosure rules. The second largest sector, MHT manufacturing, steadily increased its contribution to local research system collaboration from 6 per cent at the beginning of the period, to a strong 26 per cent at the end of it. Following a dip in 2006-2008, the LT manufacturing sector increased its contribution from 4 per cent to 13 per cent. This is notable, given that the LT manufacturing sector is not among the largest contributors of innovation-active employment in general.

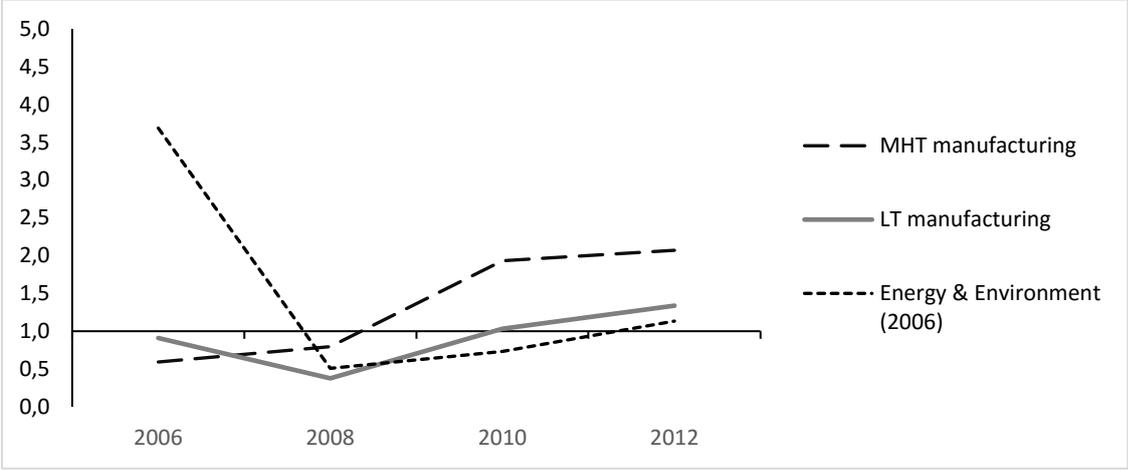
Figure 4-9 Sector contribution to local research system collaboration. Two out of the three largest sectors. One sector is not reported due to data disclosure reasons.



As above, data on commitment levels cannot be reported for the sector that exhibited the highest commitment level in 2010-2012. This sector increased its commitment levels steadily through the period. Figure 4-9 above also portrays an interesting picture of steadily increasing commitment scores in MHT and LT manufacturing sectors of Buskerud. Moreover, following a distinct drop in the initial commitment of the Energy & Environment sector, the sector has recovered and ranked as the fourth

most committed sector at the end of the period. In essence, the largest contributors to research-system collaboration in Buskerud are also the most committed sectors.

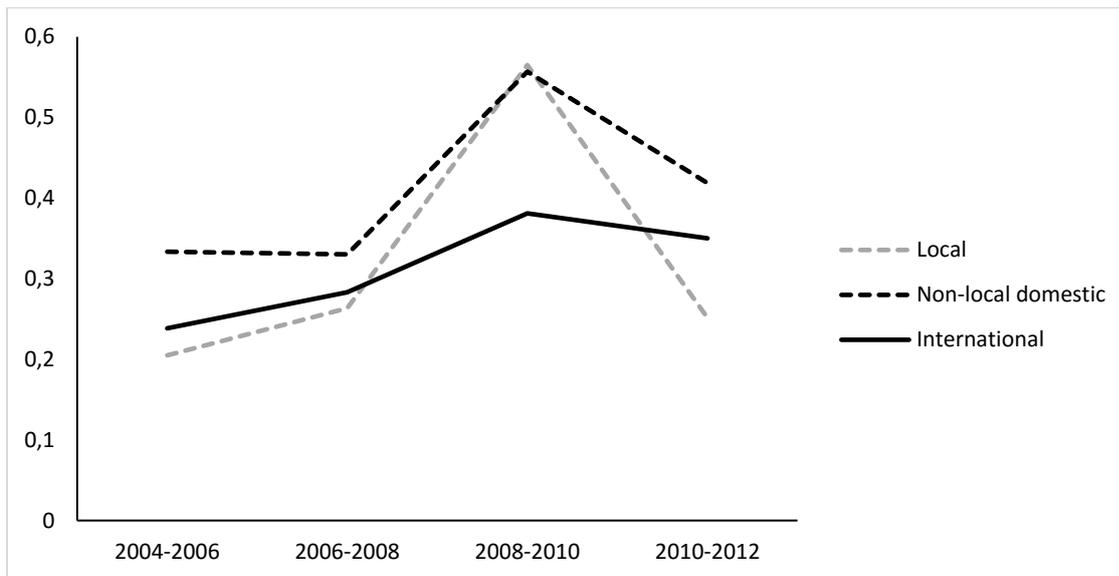
Figure 4-10 Sector commitment to local research system collaboration. The most committed at the beginning and end of the period. *Note: The most committed sector in 2010-2012 is not reported due to data disclosure reasons*



4.5 The broad definition of RIS: Local inter-firm linkages

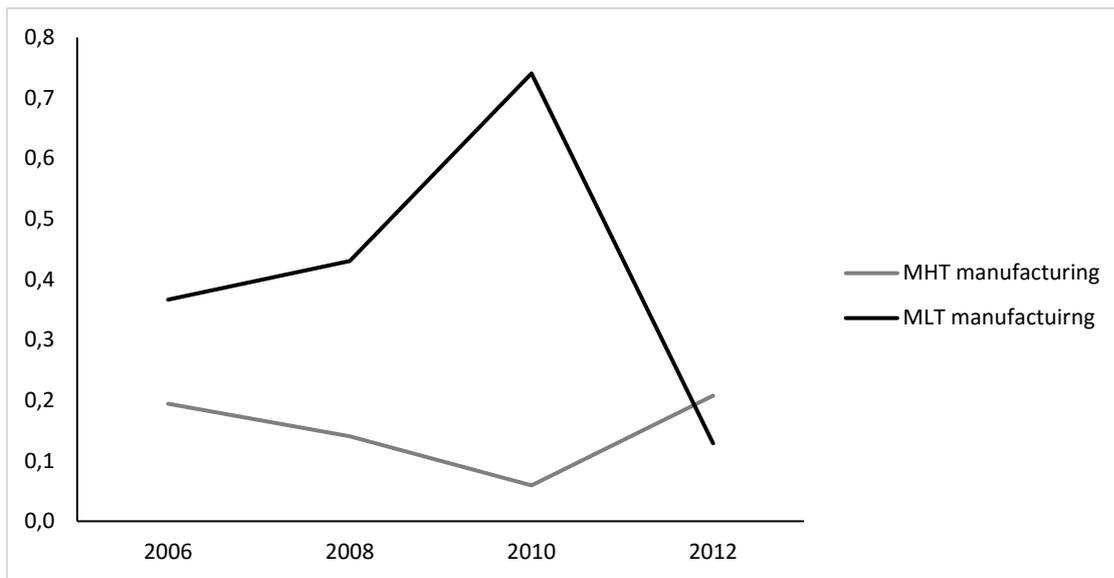
During the period 2004-2010, industrial collaboration at all geographical scales became more specialised. Still, the increase in specialisation was sharpest for local and non-local domestic industrial collaboration. Notably, local and non-local domestic industrial collaboration was in 2008-2010 much more dominated by a limited number of industrial sectors, than was international industrial collaboration, suggesting that 'global pipelines' of the region are broader than the local collaboration networks which define a working RIS. The end of the period witnessed a sharp decrease in concentration of local industrial linkages and non-local domestic linkages. Interpreting this against the background of Figure 4-1 and Figure 4-2 suggests this was driven by the entry of local sectors into non-local domestic industrial collaboration.

Figure 4-11 Sector concentration of industrial collaboration in Buskerud.



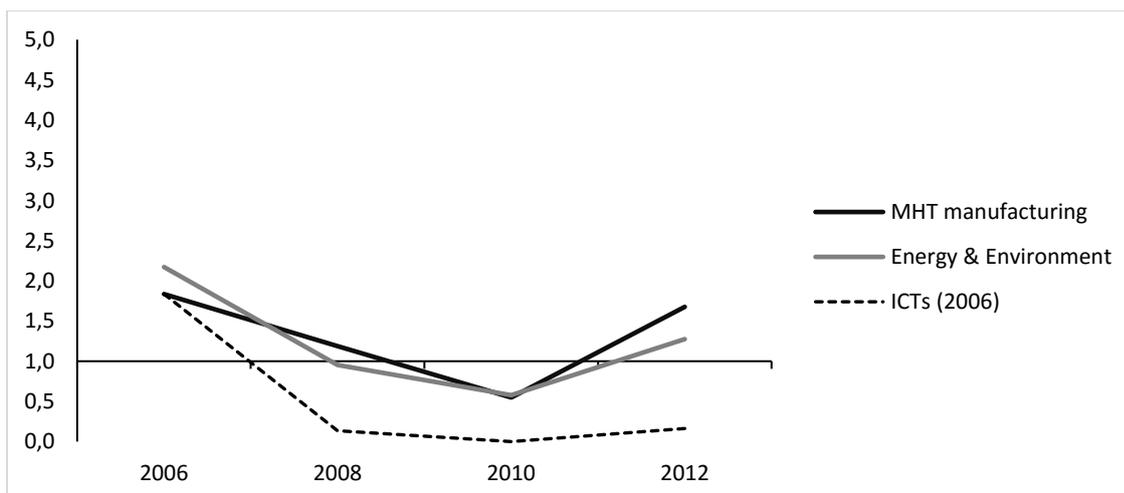
The last CIS wave reported a dramatic decline in the relative contribution of MLT manufacturing to local industrial collaboration in Buskerud. While this sector at the beginning of the period contributed a strong 37 per cent and increased to a peak of 74 per cent in 2008-2010, it dropped to 13 per cent in 2010-2012. This must be understood against the background of the entry and particularly high relative contribution of another, non-disclosed industrial sector.

Figure 4-12 Sector contribution o local industrial collaboration in Buskerud. Two out of the three largest during the period. One sector is not reported due to data disclosure reasons.



Measured in terms of commitment, the three largest sectors for which data can be reported were MHT manufacturing, Energy & Environment and ICTs. The most notable patterns in Figure 4-12 is the exit of the ICT sector from local collaboration. Moreover, following decreasing levels in the three first rounds of the CIS, MHT manufacturing and Energy & Environment strengthened their commitment at the end of the period. This is notable, because both are sectors that rank high also in terms of contribution to research system collaboration (MHT manufacturing) or in terms of commitment to such collaboration (Energy & Environment). Thus, they are sectors where firms have positioned themselves at the intersection between local research system networks and local industrial networks.

Figure 4-13 Sector commitment to local industrial collaboration in Buskerud. One sector is not reported due to data disclosure reasons.



4.6 Summary

Buskerud exhibited strong employment growth during the period, and is highly specialised in technology-intensive manufacturing. Data on labour market mobility reveal strong preferences for inter-sector mobility between the dominant manufacturing sectors, and the smaller ICT, Technical & Scientific services and Oil & Gas sectors. A cluster of skill-related industries that is only weakly linked to the manufacturing base is comprised of mining, construction, infrastructure and the primary industries.

By national standards, the region is a strong performer in terms of innovation-active employment, maintaining stable levels that are well above what would be expected given the industrial composition of the region and national sector-level trends. However, this strong foundation for the construction of RIS has not necessarily materialized as such, as the region exhibit a more clear-cut trend towards a 'regionalized national innovation system' with strong international ties than a networked regional innovation system. Particularly indicative of this strong year-to-year fluctuations in local collaboration driven by the entry and exit of certain dominant sectors, and a more clear-cut strengthening of linkages to non-local research system institutions (presumably in Trondheim or in the Capital) that is paralleled by stable and strong international ties.

Still, the contribution and commitment of the MHT manufacturing sector to local research system collaboration increased steadily while the ICT sector more or less withdrew from local industrial collaboration.

5 Finnmark

5.1 Region overview

The VRI region of Finnmark account for approximately 1.4 per cent of Norwegian employment, and is strongly specialised in primary industries, mining & quarrying, and LT manufacturing. Due to the small size of the region, complete statistics cannot be reported.

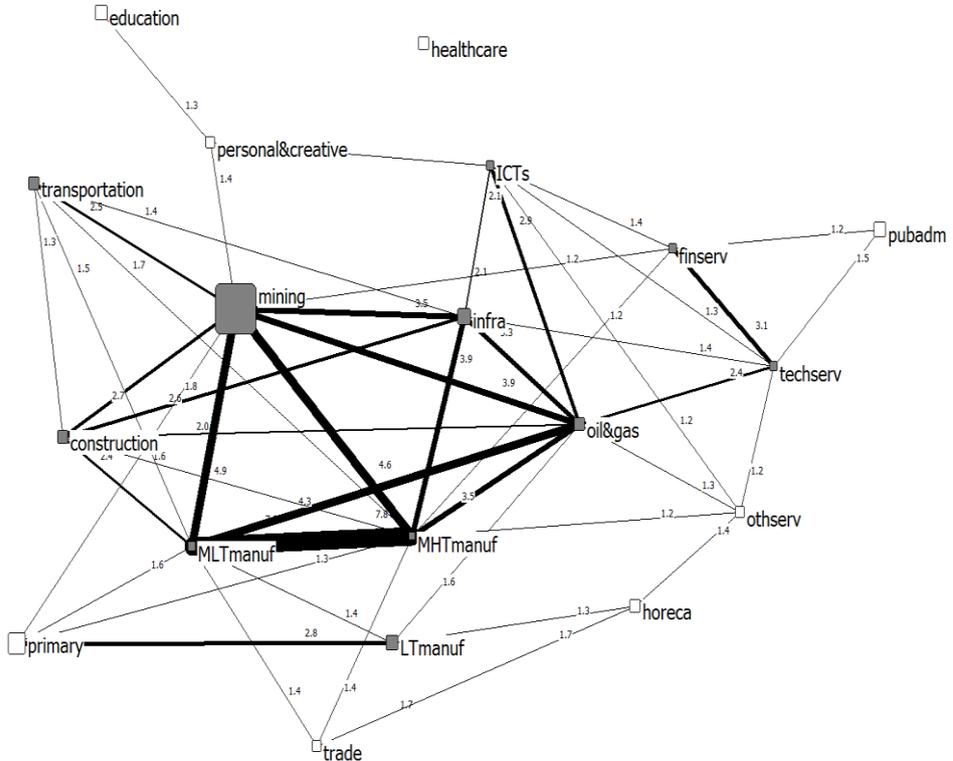
The region experienced an overall employment growth of 7.5 per cent during the period considered, with particularly strong performance in the Mining & Quarrying and manufacturing industries except the HT manufacturing sector that is not represented in the region. While exceptional growth in Oil & Gas employment must understood against the background of limited activity in this sector at the beginning of the period, location quotients of 1.12 and 0.99 in 2010 and 2012 respectively reflect that there is now substantial regional Oil & Gas activity.

Table 5-1 Location quotients & growth rates, Finnmark. Sectors marked with grey are fully covered in the harmonized CIS sample

	Location quotients				Employment growth
	2006	2008	2010	2012	2006-2012
Primary	2,20	2,35	2,45	2,67	-0,20 %
Mining & Quarrying	3,04	3,25	7,93	8,15	223,39 %
Oil & Gas	0,07	0,24	1,12	0,99	(2657 %)
HT manufacturing	0	0	0	0	0 %
MHT manufacturing	0,10	0,09	0,09	0,12	27,59 %
MLT manufacturing	0,35	0,42	0,42	0,46	21,26 %
LT manufacturing	0,96	1,07	1,11	1,35	23,36 %
Infrastructure	1,38	1,51	1,57	1,58	31,33 %
Construction	1,12	1,06	1,01	0,98	3,16 %
Trade	0,84	0,87	0,85	0,84	0,55 %
Transportation	1,02	0,97	0,99	1,05	1,81 %
Horeca	1,08	1,12	1,06	1,02	-0,25 %
ICTs	0,59	0,54	0,54	0,50	-4,43 %
Financial Services	0,54	0,55	0,55	0,54	5,47 %
Technical & Scientific services	0,56	0,52	0,50	0,45	0,47 %
Other services	0,93	0,93	0,83	0,82	-0,89 %
Public administration	1,50	1,51	1,38	1,40	8,34 %
Education	1,31	1,29	1,27	1,25	3,45 %
Healthcare	1,13	1,14	1,11	1,09	6,43 %
Personal & Creative	0,88	0,86	0,83	0,81	5,13 %
Proportion of domestic employment & employment growth in region	1,45 %	1,42 %	1,46 %	1,43 %	7,46 %

From Figure 5-1, it is evident that the LT manufacturing industry which is over-represented in the region is skill-related foremost with the primary sector that is comprised of farming, forestry, fisheries and aquaculture. A cluster of industries with stronger revealed skill-relatedness is comprised of the large mining and infrastructure sectors in the region. It includes the Oil & Gas sector, and the MHT and MLT manufacturing industries in which the region has limited employment. ICTs and Technical & Scientific Services have limited activity in the region, and both exhibit comparatively strong skill-relatedness with the Oil & Gas sector.

Figure 5-1 Skill-relatedness revealed by local labour market mobility in Finnmark, 2002-2012. Line thickness expresses the ratio of observed local mobility over expected mobility, i.e. the degree of revealed skill relatedness. Node size signifies location quotients. Grey nodes are sectors included in the innovation analysis. Only linkages where observed/expected > 1.1 are depicted



5.2 The micro-foundations for RIS

The first line in Table 5-2 below gives the number of establishments in the sample, i.e. the number of establishment in Finnmark that belong to enterprises sampled by the CIS. The second line gives the number of establishment that those sampled are meant to represent, i.e. the population size estimated based on sampling weights provided by Statistics Norway. Due to very low N, complete statistics cannot be reported for Finnmark. Doing so would involve breaching disclosure rules that prohibit the use of data in manners that reveal the identity and behaviour of individual firms. Moreover, results would be very difficult to interpret.

Table 5-2 Number of observations (establishments)

	CIS2006	CIS2008	CIS2010	CIS2012
Unweighted (sample)	131	126	117	133
Weighted (population)	266	254	254	263

Keeping in mind the low number of observations, Figure 5-2 demonstrate that innovation activity is in Finnmark well below the levels that would be expected given the composition of CIS employment in the region. Moreover, the gap between expected and observed activity has increased during the later rounds of the CIS.

Figure 5-2 Observed vs. expected innovation activity

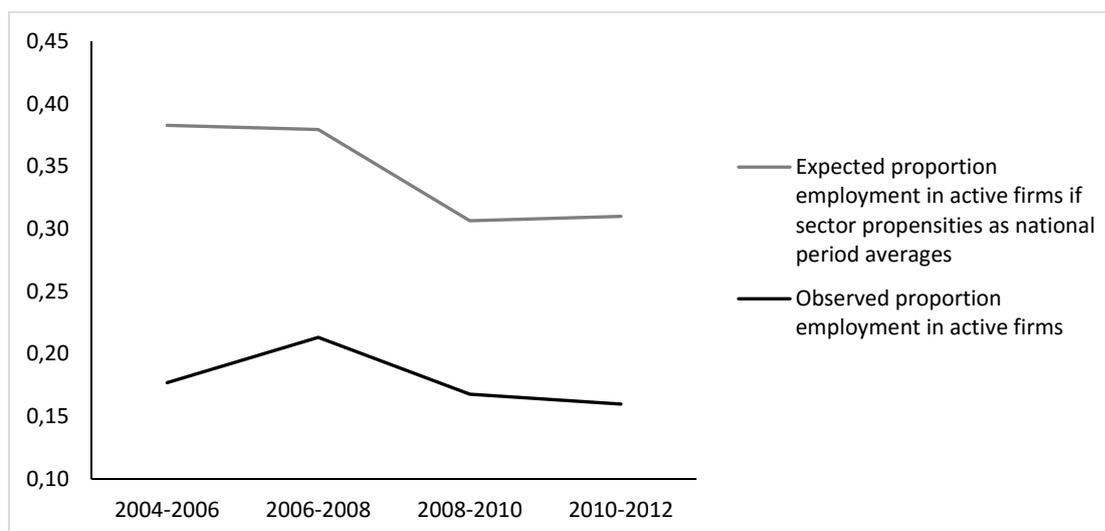
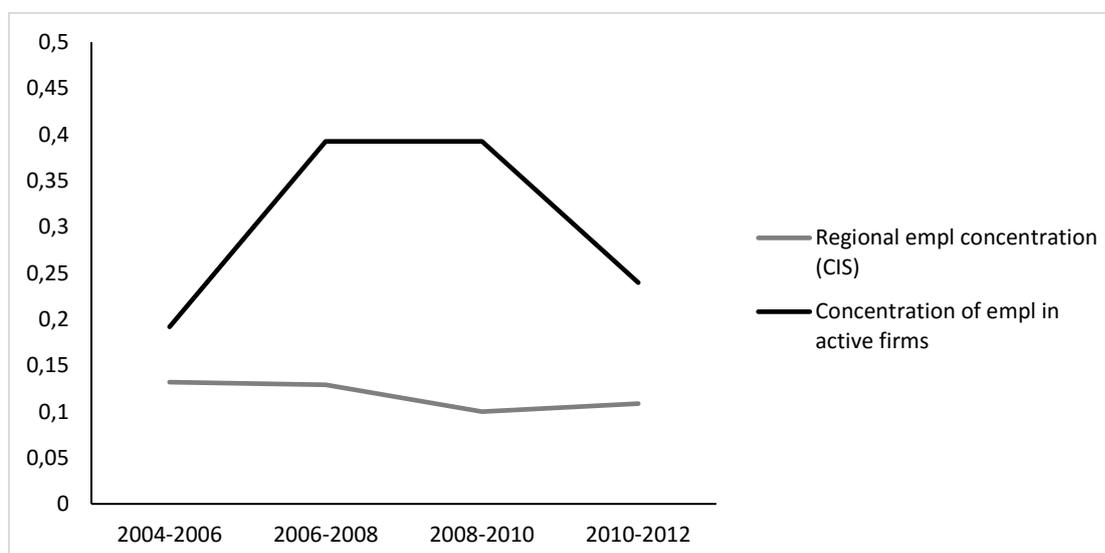


Figure 5-3 below shows how innovation active employment is much more concentrated, i.e. accounted for by much smaller number of industrial sectors, than is CIS employment as a whole. While the low N problem must be kept in mind, this adds to the evidence that particular policy emphasis needs to be put on mobilising more firms and a broader range of industrial sectors into development work.

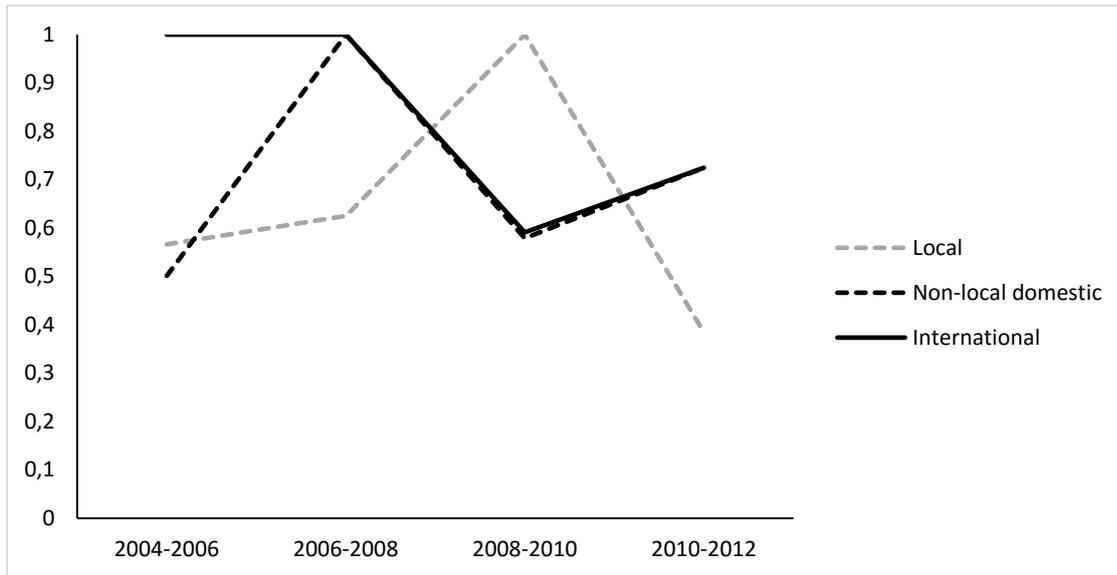
Figure 5-3 Concentration of innovation active employment. Herfindahls index



5.3 Local innovation collaboration

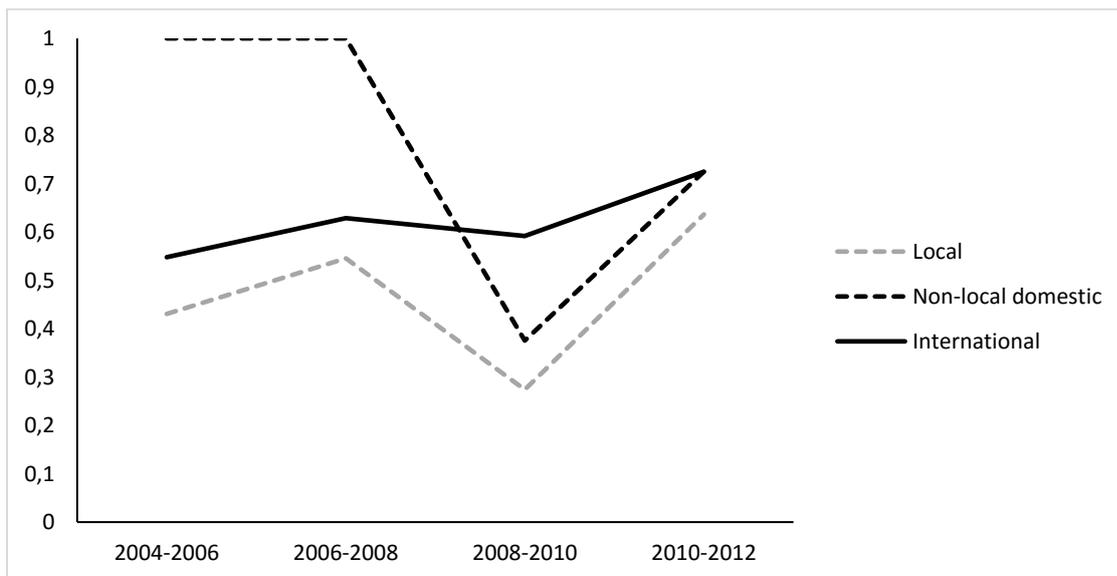
The need for broader mobilisation is further underscored once the sectorial concentration of research system linkages is considered. Concentration scores fluctuation between the different periods yet generally exceptionally high. In 2008-2010, one single industrial sector accounted for all local research system collaboration; and the apparent drop in concentration from 1 to 0.38 in 2010-2012 was driven by the entry of two additional sectors into such collaboration.

Figure 5-4 Sector concentration of research system collaboration in Finnmark.



This point is further underscored by the concentration of local industrial system linkages, which also have fluctuated around exceptionally high levels. A concentration score of 0.63 for local industrial collaboration at the end of the period result from activity in one comparatively large sector and one smaller.

Figure 5-5 Sector concentration of industrial collaboration in Finnmark.



5.4 Summary

The small VRI region of Finnmark is highly specialised in primary industries (agriculture, forestry, fisheries & aquaculture), mining & quarrying and LT manufacturing, in addition to public administration & defence. The HT manufacturing sector is absent from the region, while employment in the Technical & Scientific Services, ICTs, MHT and MLT manufacturing sectors is strongly under-represented. Employment in the Oil & Gas sector is as would be expected given the size of the region. From local labour market mobility during the period, it is evident that cross-fertilization occurs most intensively between the relatively small MHT and MLT manufacturing sectors, and include the relatively large Mining & Quarrying sector. LT manufacturing, by contrast, is associated by labour market mobility foremost with the primary sector; while the limited Technical & Scientific Services and Financial Services employment in the region are skill-related most strongly with each other and with Oil & Gas.

The region strongly under-performs in terms of innovation-active employment: Levels are well below those that would be expected even when the distinctively low-tech industrial composition of the region is accounted for, and there is a clear mismatch between the strong concentration of active employment and the lower concentration of CIS employment in general. Innovation collaboration is strongly concentrated and thus receptive to the entry and exit of a limited number of sectors.

6 Hedmark & Oppland

6.1 Region overview

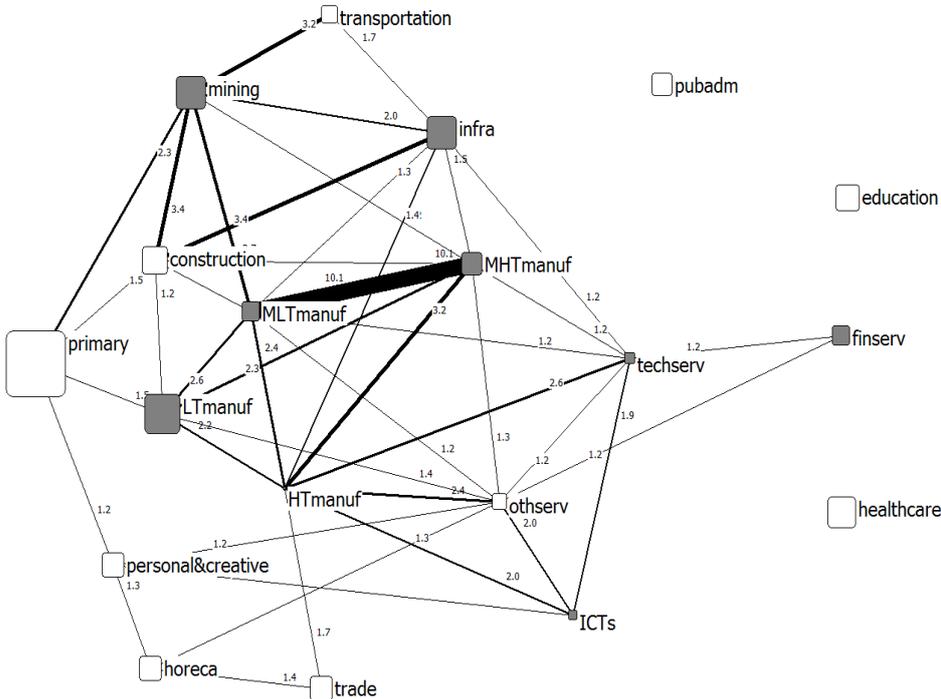
The VRI region of Hedmark & Oppland accounted in 2012 for just below 7 per cent of Norwegian employment. It is specialised in the primary industrial sectors, mining & quarrying and LT manufacturing, and experienced only 2.1 per cent employment growth from 2006 to 2012. Growth was particularly strong in the mining & quarrying industry, and in public administration, education & healthcare. Activity in the Oil & Gas industry group is absent, and the fastest growing sectors during the period were Mining & Quarrying and Technical & Scientific Services. Given that it includes several profiled tourist destinations, it is notable that employment in the Hotels, Restaurants & Catering industry decreased by almost 10 per cent.

Table 6-1 Location quotients & growth rates, Hedmark & Oppland. Sectors marked with grey are fully covered in the harmonized CIS sample

	Location quotients				Employment growth
	2006	2008	2010	2012	2006-2012
Primary	2,13	2,20	2,31	2,34	-14,27 %
Mining & Quarrying	1,10	1,13	1,11	1,24	29,04 %
Oil & Gas	0,00	0,00	0,00	0,00	0,00 %
HT manufacturing	0,23	0,24	0,26	0,28	3,98 %
MHT manufacturing	1,08	1,03	0,92	0,94	-15,95 %
MLT manufacturing	0,83	0,83	0,85	0,80	-15,79 %
LT manufacturing	1,51	1,46	1,47	1,49	-17,73 %
Infrastructure	1,30	1,15	1,17	1,23	2,83 %
Construction	1,12	1,15	1,14	1,12	11,10 %
Trade	0,94	0,95	0,96	0,97	-0,15 %
Transportation	0,70	0,73	0,73	0,79	5,06 %
Horeca	1,08	1,04	1,02	0,97	-9,46 %
ICTs	0,53	0,52	0,53	0,52	6,87 %
Financial Services	0,73	0,76	0,77	0,80	8,58 %
Technical & Scientific services	0,59	0,57	0,59	0,57	14,79 %
Other services	0,81	0,82	0,77	0,72	-5,68 %
Public administration	0,96	0,98	0,91	0,95	9,20 %
Education	0,99	0,99	1,02	1,05	9,45 %
Healthcare	1,15	1,17	1,19	1,20	9,49 %
Personal & Creative	1,00	1,01	1,03	1,01	8,59 %
Proportion of domestic employment					
Regional employment	7,07 %	6,91 %	6,78 %	6,66 %	2,11 %

From Figure 6-1, it is evident that local labour market mobility in Hedmark & Oppland signal a strong degree of skill-relatedness between the MLT and MHT manufacturing industries, and, less distinct, the HT manufacturing. All three are, however, small. The absence of clear-cut clusters of strongly skill-related industries in which the region is also specialised is a striking characteristic of Hedmark & Oppland that points to weak endogenous knowledge dynamics and warrant RIS intervention.

Figure 6-1 Skill-relatedness revealed by local labour market mobility in Hedmark & Oppland, 2002-2012. Line thickness expresses the ratio of observed local mobility over expected mobility, i.e. the degree of revealed skill relatedness. Node size signifies location quotients. Grey nodes are sectors included in the innovation analysis. Only linkages where observed/expected > 1.1 are depicted



6.2 Baseline innovation profile

The first line in Table 6-2 below gives the number of establishments in the sample, i.e. the number of establishment in Hedmark & Oppland that belong to enterprises sampled by the CIS. The second line gives the number of establishment that the sample represents, i.e. the population size estimated based on sampling weights provided by Statistics Norway.

Table 6-2 Number of observations (establishments)

	CIS2006	CIS2008	CIS2010	CIS2012
Unweighted (sample)	675	665	651	637
Weighted (population)	1 414	1 270	1 232	1 162

Figure 6-2 and 6-3 describes key development trends. During the period, Hedmark & Oppland exhibited decreasing levels of innovation activity. Moreover, it is difficult to see any clear-cut trends with respect to innovation collaboration, as levels fluctuated strongly between the different waves of

the CIS. One exception is indications of a recovery in the level of non-domestic research system collaboration observed at the end of the period, which indicate regionalization of the national innovation system.

Figure 6-2 Innovation profile, relative to Norway = 1

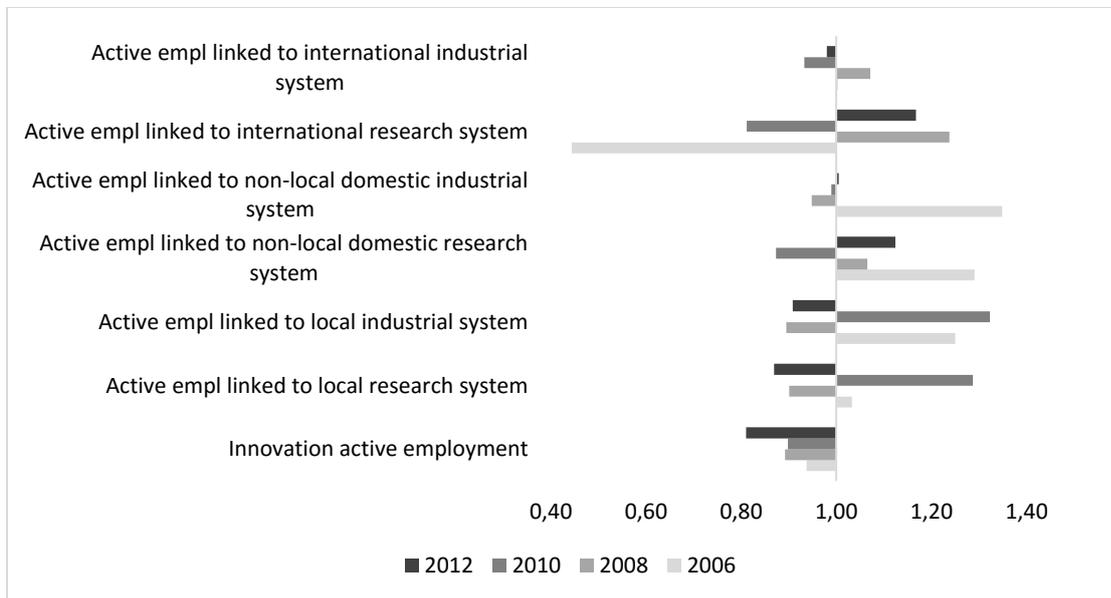
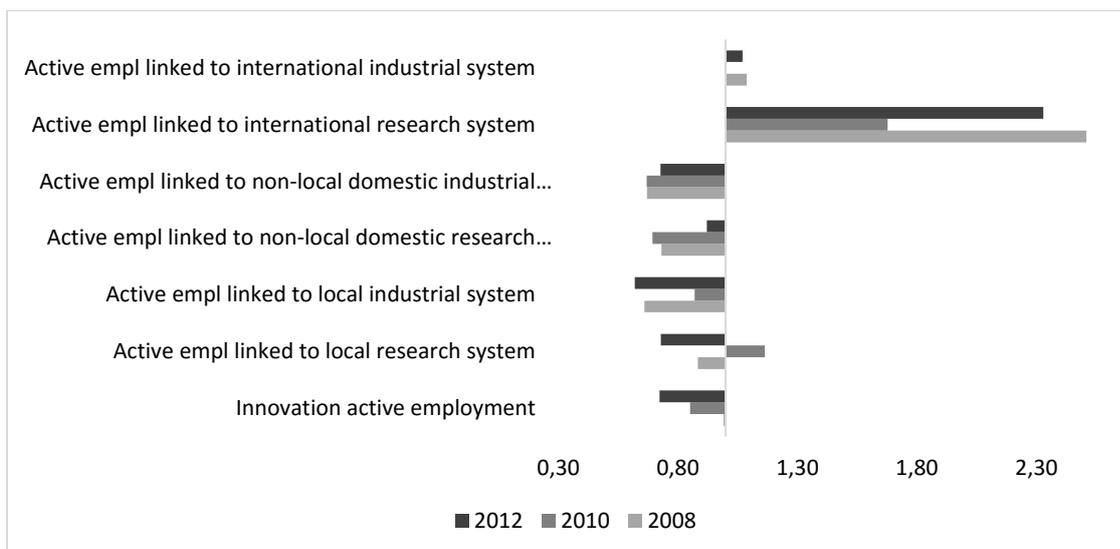


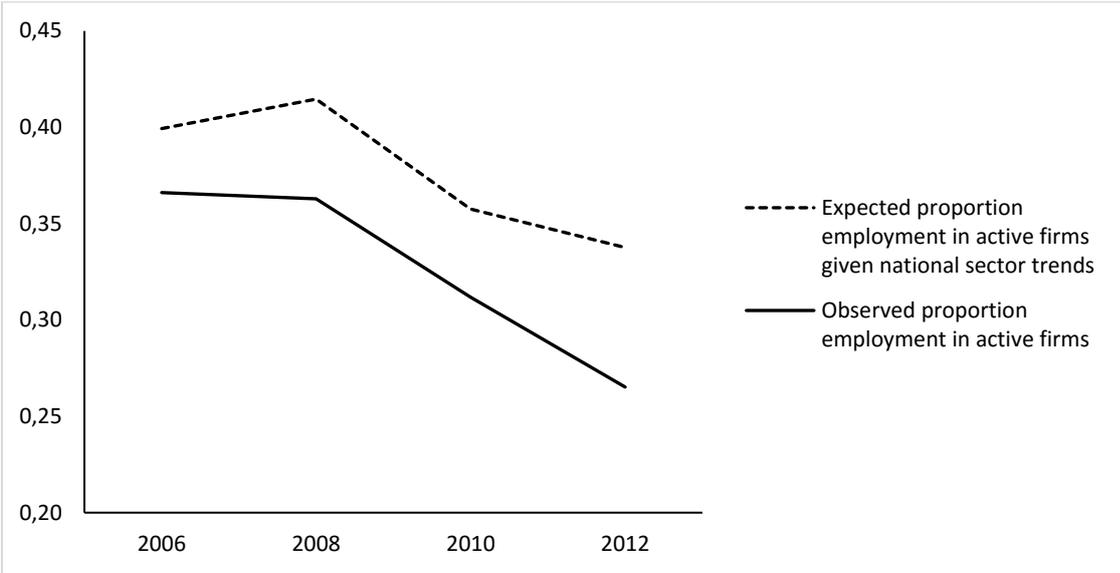
Figure 6-3 Innovation profile, relative to region in 2006 = 1



6.3 The micro-foundations for RIS

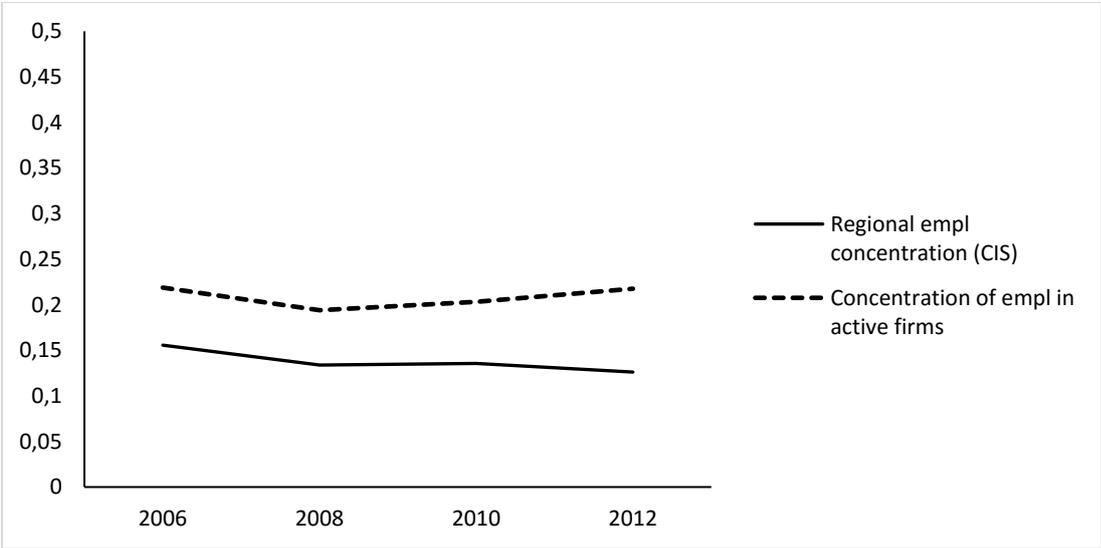
Throughout the period considered, Hedmark & Oppland has exhibited innovation activity levels below what would be expected given the composition of CIS employment in the region, and the (downward) national sector trends. The gap between expected and observed levels increased from 3 percentage-points at the beginning of the period, to 7 percentage-points at the end of the period. This suggests that the micro-foundations for the construction of RIS that build on industries sampled in the CIS in this region are very weak, and may warrant policy attention dedicated to mobilizing more firms into engaging in development work before emphasis is put on stimulating specific types of innovation activities (e.g. local research system collaboration).

Figure 6-4 Observed vs. expected innovation activity in Hedmark & Oppland



Decreasing levels of employment concentration in the harmonized CIS (Figure 6-5) sample suggests that the regional industrial structure captured by this survey has become more diverse; yet, it is paralleled by increasing concentration of innovation active employment. This is further evidence that the region has failed in terms of mobilization into development work, and underscores that firm-level intervention seeking to influence the decision of whether or not to engage is necessary in order for a stronger foundation for RIS construction to be built.

Figure 6-5 Concentration of innovation active employment in Hedmark & Oppland



CIS innovation employment is dominated by LT and MLT manufacturing industries, with the more technology-intensive MHT manufacturing sector ranking as the third largest contributor. Combined, these three sectors accounted for 77 per cent of active employment both at the beginning and at the end of the period. This suggests that the increase in concentration of innovation-active employment observed from 2006-2008 is driven by a reduction in the contribution from other sectors to regional innovation activity, and underscores again the need for a stronger focus on strengthening the micro-foundations for RIS.

Figure 6-6 Sector contribution to innovation-active employment in Hedmark & Oppland. The three largest at the beginning and end of the period

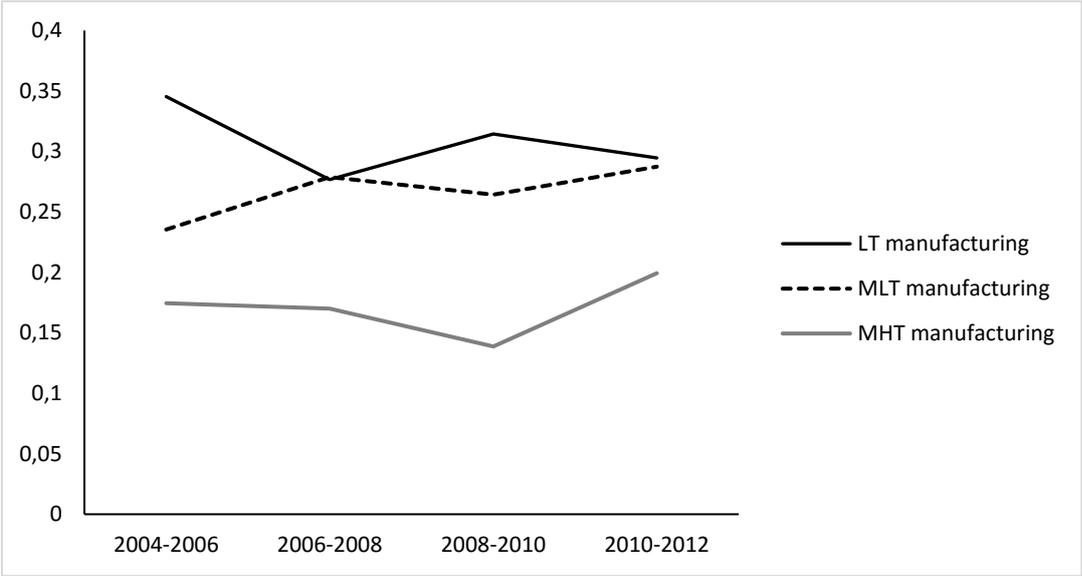
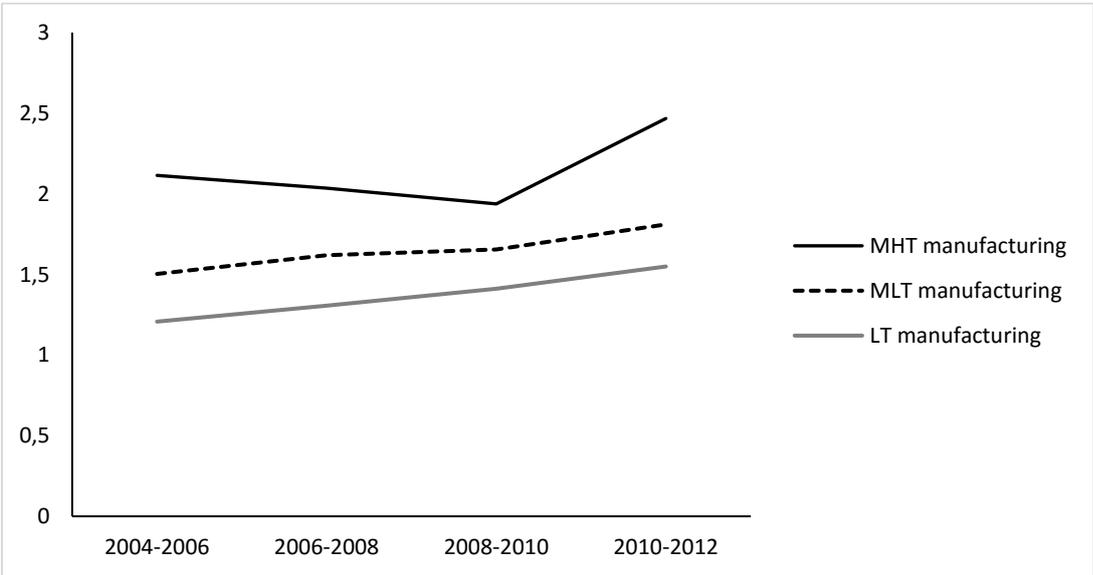


Figure 6-7 shows that the three manufacturing sectors increased their commitment to development work during the period considered. This increase has been stable for LT and MLT manufacturing, while MHT manufacturing exhibited a decline in commitment during the early stages of the period only to recover in the last round of the CIS. Thus, the largest contributors of innovation-active employment are more over-represented at the end of the period than at the beginning, underscoring again that a main challenge appears to broader mobilisation of firms and industries into development work.

Figure 6-7 Sector COMMITMENT to innovation activity. The three most committed at the beginning and end of the period



6.4 The narrow definition of RIS: Local research system linkages

Figure 5-7 shows how local and international research system linkages became marginally less concentrated during the period, and how this was paralleled by a marginal increase in concentration of non-local research system linkages. This and period-to-period fluctuations translate into absence of clear-cut trends.

Figure 6-8 Sector concentration of research system collaboration in Hedmark & Oppland.

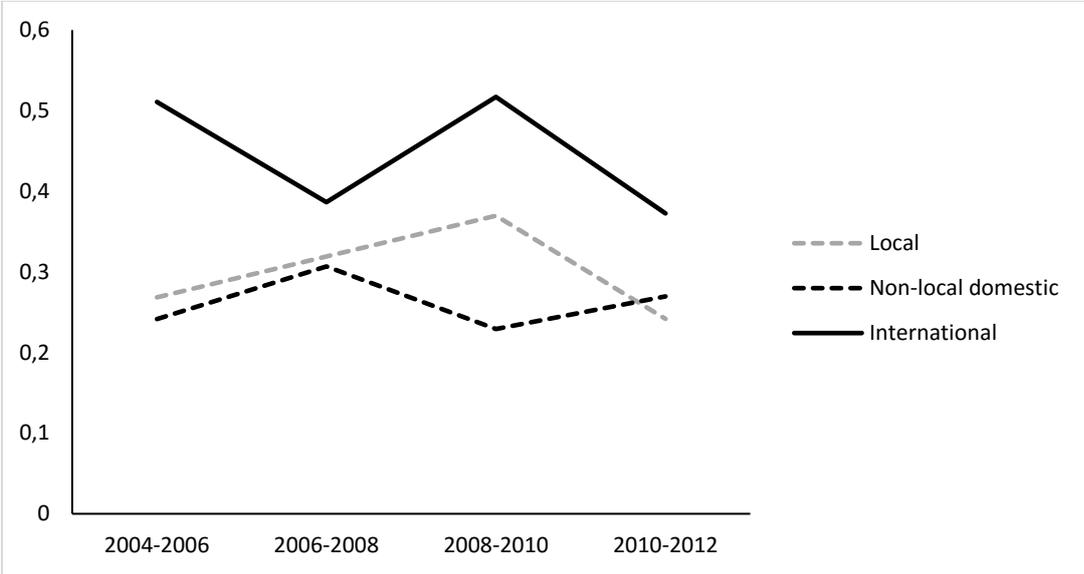
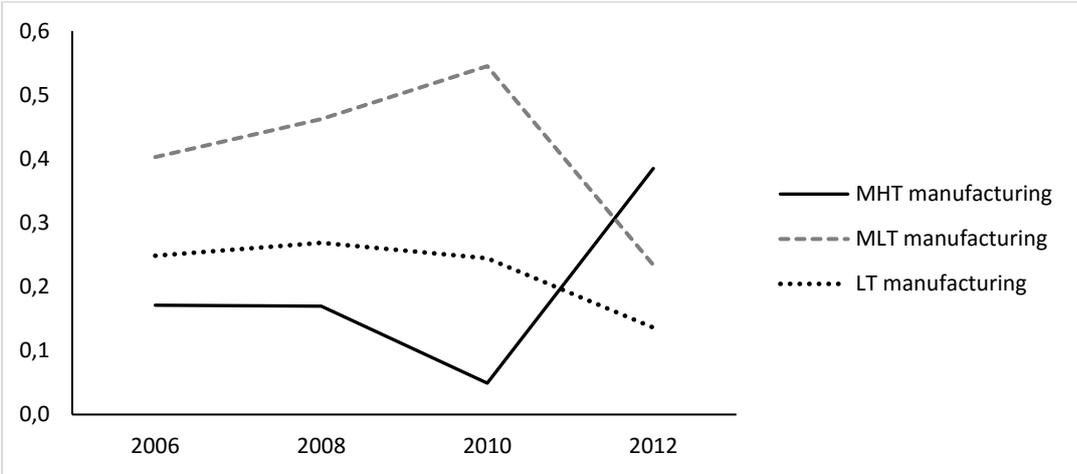


Figure 5-8 demonstrates that the drop in concentration at the end of a period is directly related to a more even contribution of MHT and MLT manufacturing to local research system collaboration. Thus is due to a strong increase in the contribution from MHT, and a parallel decrease in the contribution from MLT. Notably, the relative contribution of the LT manufacturing sector decreased moderately yet steadily throughout the last stages of the period. Thus, the decrease in overall concentration conceal what is essentially increased dominance of the more technology-intensive MHT manufacturing sector.

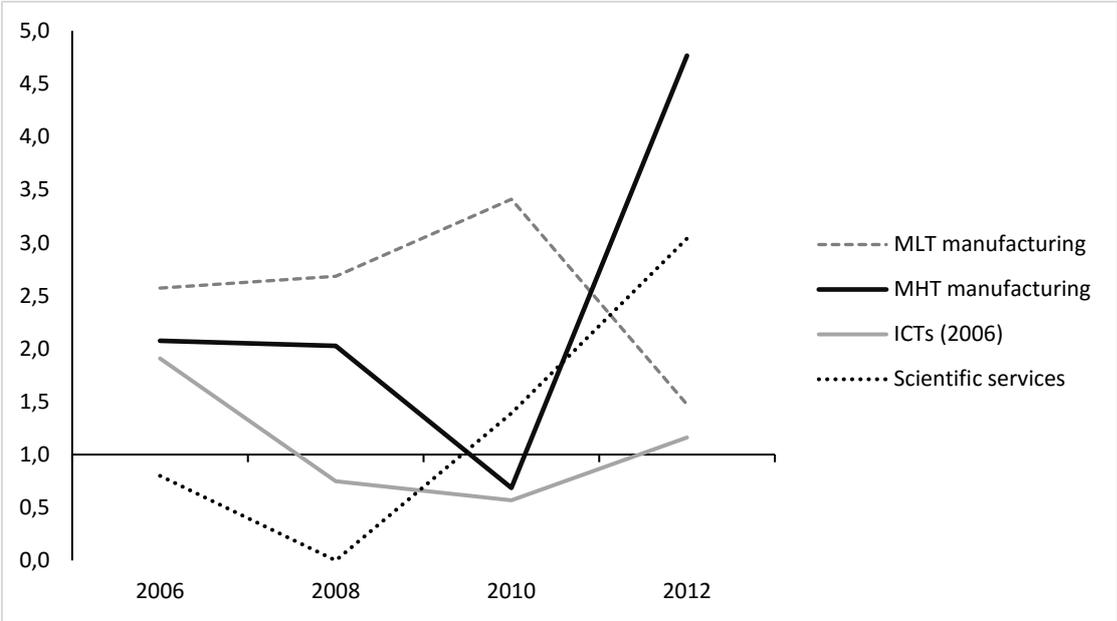
Figure 6-9 Sector contribution to local research system collaboration in Hedmark & Oppland.
The three largest at the beginning and end of the period.



The commitment levels exhibited by the largest contributors also fluctuated strongly during the period, suggesting that local research system collaboration occurs on a sporadic basis. Absence of stability indicate low continuity, and absence of commitment from these sectors beyond the execution of specific projects. By contrast, the commitment levels of the Scientific Services sector increased

steadily as of the 2006-2008 CIS round. The ICT sector exhibited a sharp decline in commitment during the early stages of the period, yet, strengthened its commitment to local research system collaboration at the end of the period. The latter is notable, because it differs from the national trend of decreasing contribution and commitment of this sector to local collaboration. Presumably, it mirrors the establishment of a national 'Centre for Expertise' in information security.

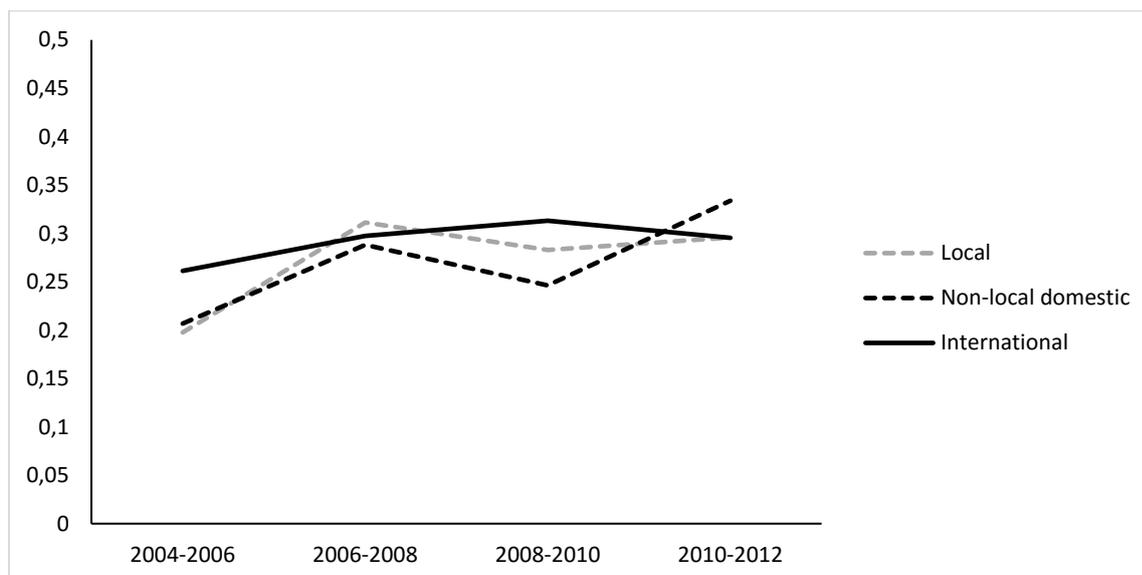
Figure 6-10 Sector commitment to local research system collaboration in Hedmark & Oppland. The three largest at the beginning and end of the period.



6.5 The broad definition of RIS: Local inter-firm linkages

In contrast to what was the case for research system collaboration, the industrial networks maintained by firms in Hedmark & Oppland become substantially more dominated by certain sectors during the period considered. The increase in concentration was particularly strong for non-local domestic linkages, suggesting that the region at the end of the period maintain narrower networks to the domestic economy than it did at the outset. The increase in concentration of local network linkages was particularly large from the first to the second phase of the period.

Figure 6-11 Sector concentration of industrial collaboration in Hedmark & Oppland.



This first part of the period was characterized by an overall decline in local industrial collaboration (cf. Figure 6-3), and by a strong increase in the relative contribution of the MLT manufacturing sector to such networks. During the years 2006-2010, the contribution of this sector remained stable at levels approximating 50 per cent, before it dropped to 10 per cent in 2010-2012. This was paralleled by an increase in the contribution of the LT manufacturing sector, and by growing contributions from the financial services sector.

Figure 6-12 Sector contribution to local industrial collaboration in Hedmark & Oppland. The three largest at the beginning and end of the period.

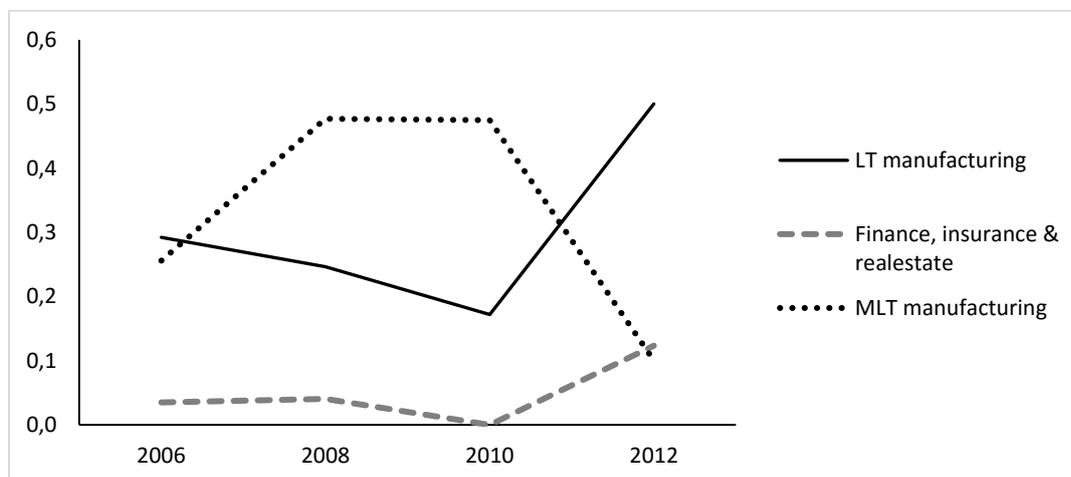
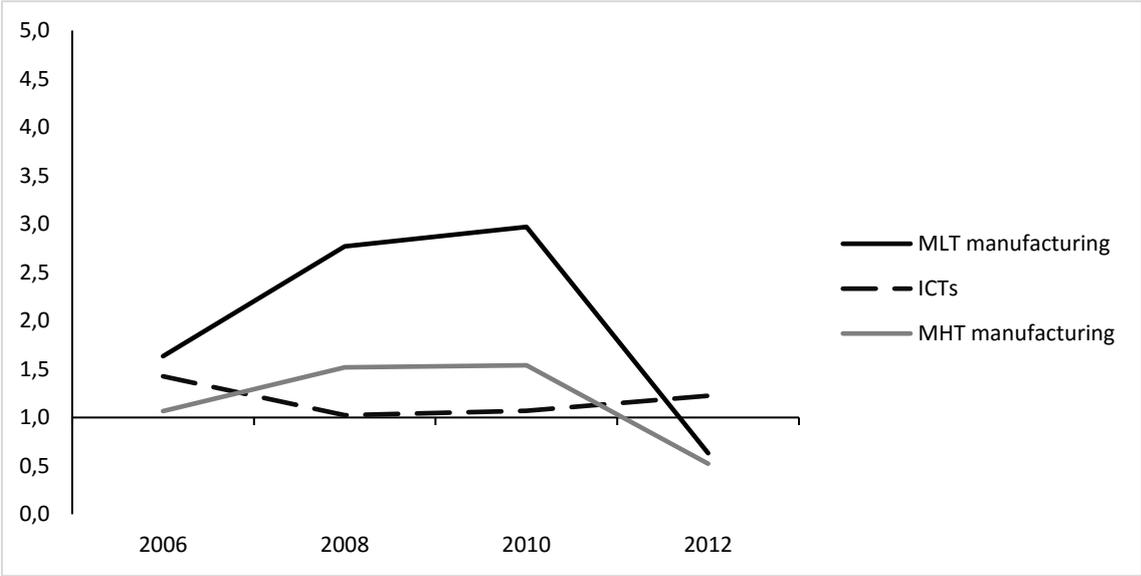


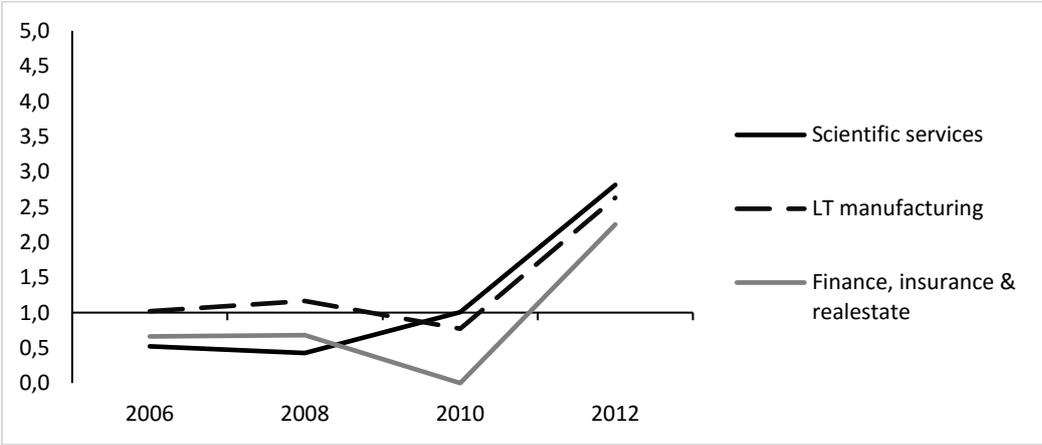
Figure 6-13 illustrates that the ICT sector in the beginning of the period was among the top-three in terms of commitment to local industrial collaboration. This commitment then declined, and increased somewhat at the end of the period. Yet, as is evident from Figure 6-14, this slight increase in commitment was not sufficient for the sector to rank among the three most committed to local industrial networking in 2010-2012. The commitment of MHT and MLT manufacturing declined substantially at the end of the period, while the commitment of scientific services, LT manufacturing and financial services increased dramatically.

Figure 6-13 Sector commitment to local industrial collaboration in Hedmark & Oppland. The three largest at the beginning of the period. *The three largest at the beginning of the period.*



This means that there has been a notable change in the composition of local industrial networks in Hedmark & Oppland, with LT manufacturing, ICTs and services industries weighing more heavily in these networks and the more technology-intensive manufacturing industries weighing less heavily. It is important to note that this has been paralleled by an overall decrease of 40 per cent in the proportion of active employment that occurs in firms with a local industrial linkage.

Figure 6-14 Sector commitment to local industrial collaboration in Hedmark & Oppland. The three largest at the end of the period. *The three largest at the end of the period.*



6.6 Summary

Hedmark & Oppland is specialized in primary industries, LT manufacturing, infrastructure and construction industries, in addition to healthcare. It has a weak employment base in Technical & Scientific Services that emerge as strongly skill-related to the small HT manufacturing sector of the region. At the same time, local labour market mobility does signal cross-fertilization between the MLT and MHT manufacturing industries that are relatively well represented in the region. Given the policy emphasis of the region on tourism and experience-based industries, it is notable that Personal & Creative industries emerge as skill-related to the (small) ICT sector, the Hotels, Restaurants & Catering Sector, and to the Primary sector.

The micro-foundations for RIS construction weakened substantially during the period, with innovation-active employment declining to levels well below those initially exhibited in the region and those that would be expected given its industry structure and domestic innovation-activity trends. Fluctuating local research system collaboration and weakening local industrial collaboration is contrary to what would be expected from emerging RIS configurations. This and the strong concentration of innovation-active employment underscores that a main challenge is broader mobilisation of firms and industries into development work.

However, while local research system collaboration is dominated by the manufacturing industries that exhibit declining contribution and commitment to both types of local collaboration and are the primary drivers of relatively strong international ties, the region has managed to mobilize the small Technical and Scientific Services and ICT industries into strengthening their commitment to local research system collaboration. Both industries are also committed to local industrial collaboration, suggesting that they may be positioning themselves at the intersection between research institutions and business partners that do not themselves directly interact with such institutions. Yet, as noted above, both sectors are at present small.

7 Hordaland

7.1 Region overview

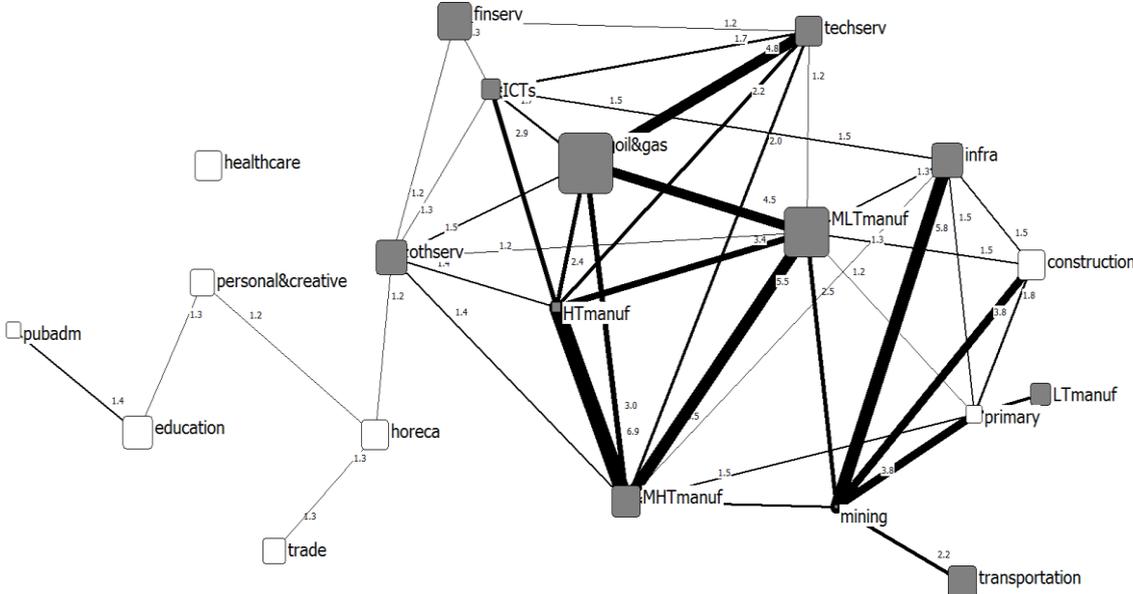
The VRI region of Hordaland contains the large-city labour market region of Bergen, and accounted in 2012 for almost 10 per cent of Norwegian employment. It experienced a healthy 9.3 per cent increase in employment from 2006, with particularly strong growth in the Oil & Gas sector, MHT manufacturing, Infrastructure & Environment, Technical & Scientific Services and the 'Other Services' that include agencies providing public and private sector organizations with temporary staff. It also experienced a sharp decline in HT manufacturing employment. Reflecting the diversity of a large urban region, it exhibits location quotients above 1 for a broad range of industries.

Table 7-1 Location quotients & growth rates, Hordaland. Sectors marked with grey are fully covered in the harmonized CIS sample

	Location quotients				Employment growth
	2006	2008	2010	2012	2006-2012
Primary	0,67	0,69	0,70	0,72	-10,48 %
Mining & Quarrying	0,41	0,36	0,44	0,36	7,10 %
Oil & Gas	1,75	1,46	1,73	1,77	105,04 %
HT manufacturing	0,79	0,69	0,71	0,50	-41,50 %
MHT manufacturing	0,96	0,84	1,07	1,05	13,43 %
MLT manufacturing	1,50	1,52	1,46	1,49	-7,57 %
LT manufacturing	0,81	0,82	0,85	0,83	-9,07 %
Infrastructure	1,11	1,16	1,15	1,14	19,48 %
Construction	1,06	1,05	1,01	1,01	13,83 %
Trade	0,89	0,89	0,90	0,89	3,46 %
Transportation	1,09	1,09	1,09	1,03	-4,24 %
Horeca	1,01	1,04	1,02	1,01	7,20 %
ICTs	0,81	0,79	0,80	0,78	12,13 %
Financial Services	1,14	1,11	1,14	1,18	10,78 %
Technical & Scientific services	0,98	1,02	0,99	0,99	28,15 %
Other services	0,92	0,95	1,00	1,14	40,40 %
Public administration	0,82	0,81	0,67	0,68	-3,00 %
Education	1,14	1,13	1,11	1,10	6,75 %
Healthcare	1,04	1,03	1,04	1,02	10,81 %
Personal & Creative	0,91	0,92	0,95	0,93	17,56 %
Proportion of domestic employment & regional employment growth	9,73 %	9,79 %	9,68 %	9,82 %	9,31 %

From Figure 7-1, it is evident that a relatively broad range of industries comprises a cluster of skill-related industries. Comparatively large MHT and MLT manufacturing sectors are skill-related with each other, and with the Oil & Gas sector. A strong Technical & Scientific Services industry and a smaller ICT industry have in common that they are densely linked by the labour market to HT manufacturing (ICTs) and to the Oil & Gas sector (Technical & Scientific Services). Interestingly, there is no revealed skill-relatedness between LT manufacturing and other manufacturing industries; instead, LT manufacturing emerge as skill-related foremost with the relatively small primary sector (which, importantly, include aquaculture) that in turn is strongly interlinked with mining, construction and infrastructure.

Figure 7-1 Skill-relatedness revealed by local labour market mobility in Hordaland, 2002-2012. Line thickness expresses the ratio of observed local mobility over expected mobility, i.e. the degree of revealed skill relatedness. Node size signifies location quotients. Grey nodes are sectors included in the innovation analysis. Only linkages where observed/expected > 1.1 are depicted



7.2 Baseline innovation profile

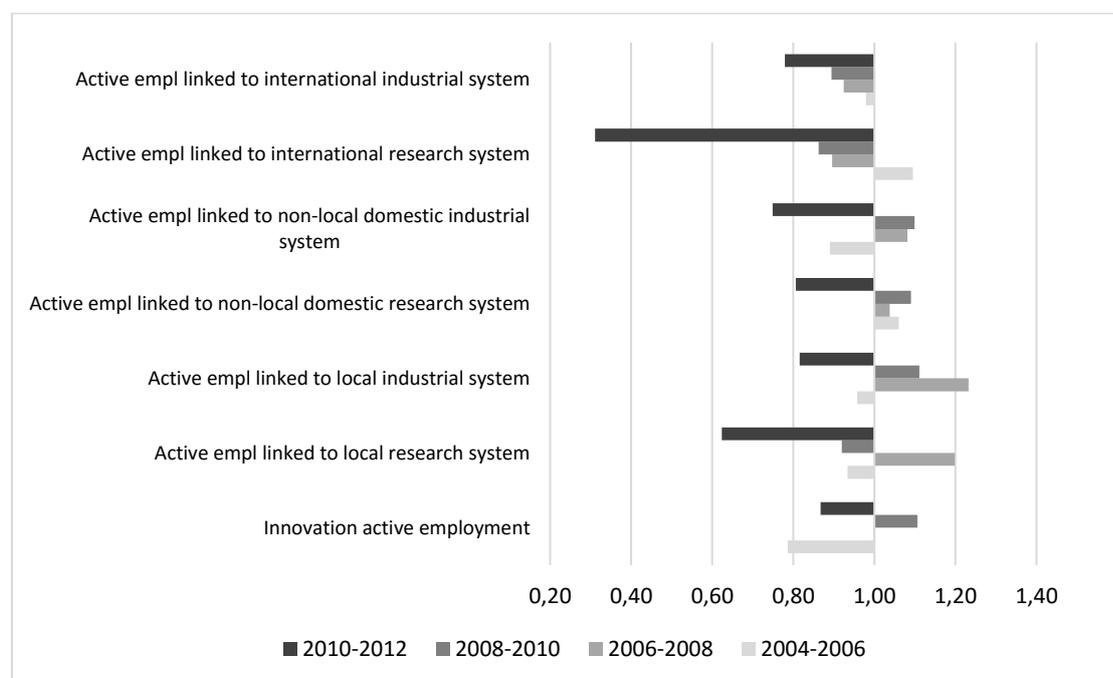
The first line in Table 7-2 below gives the number of establishments in the CIS sample. The second line gives the number of establishment that those sampled are meant to represent, i.e. the population size estimated based on sampling weights provided by Statistics Norway.

Table 7-2 Number of observations (establishments)

	CIS2006	CIS2008	CIS2010	CIS2012
Unweighted (sample)	891	897	891	918
Weighted (population)	1914	1807	1747	1726

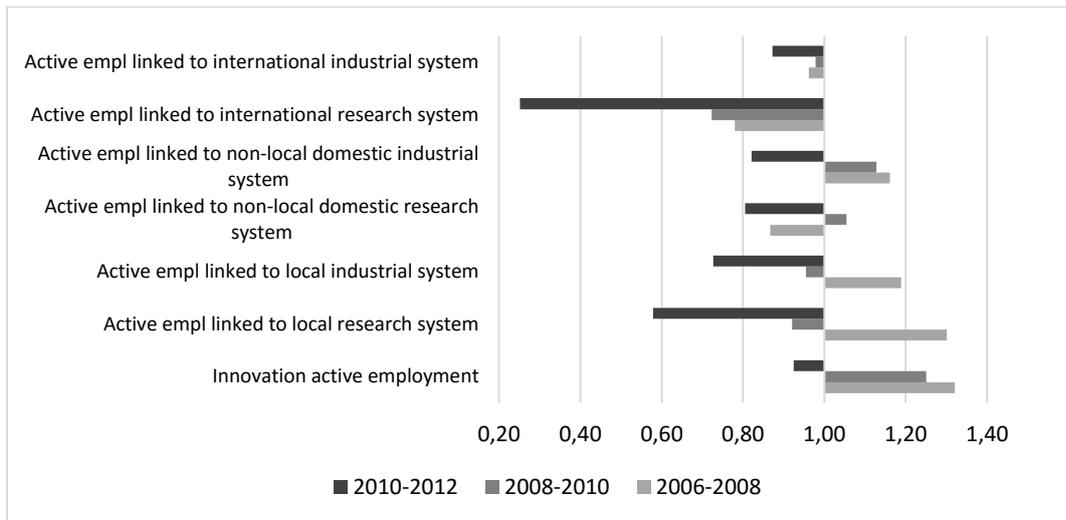
A comparatively large N means that strong period-to-period fluctuations are not to be expected due to fluctuations in the behaviour of individual firms. Still, Figure 7-2 and 7-3 below reveal that innovation-active employment has fluctuated relative to the region itself, and to the national baseline. Local research system collaboration was strong in the period 2006-2008, but has also fluctuated around the domestic (Figure 7-2) and regional (Figure 7-3) reference.

Figure 7-2 Innovation profile, relative to Norway = 1



In contrast to this, a clear trend throughout the four waves of the CIS is weakened international collaboration, most distinctively along the research system dimension but also along the industrial dimension.

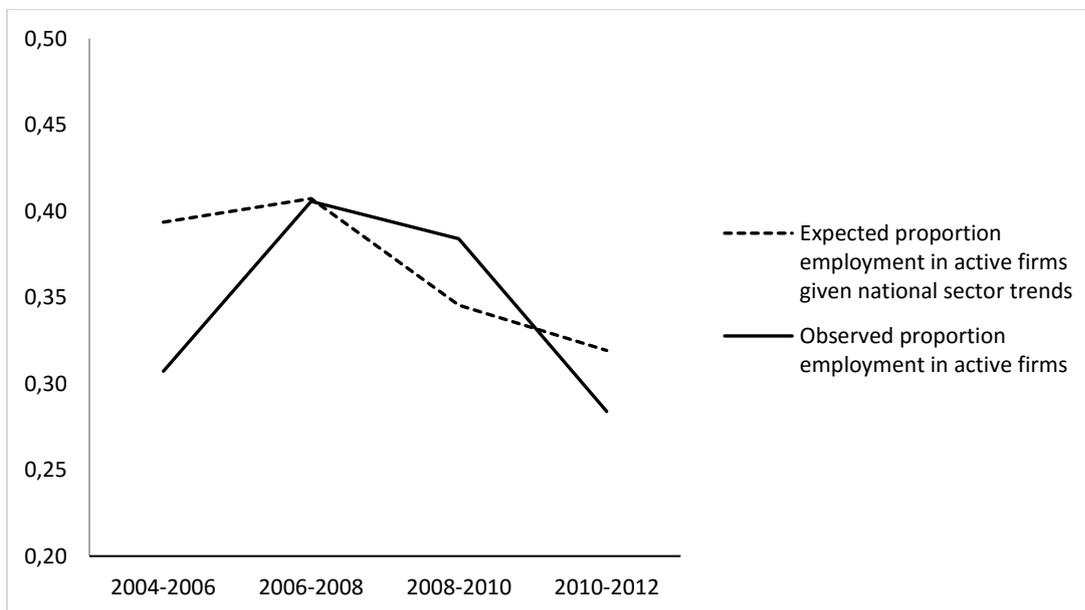
Figure 7-3 Innovation profile, relative to region in 2006 = 1



7.3 The micro-foundations for RIS

Figure 7-4 below demonstrates that observed innovation activity increased from the first to the second CIS period, and reached the levels that would be expected given the sectorial composition of employment in the region. It was somewhat above these levels in the following period, only to drop well below them at the end of it. Thus, fluctuations rather than a clear-cut positive or negative trend characterises the region.

Figure 7-4 Observed vs. expected innovation activity in Hordaland.



From Figure 7-5 below, it is evident that the difference in concentration of CIS employment and concentration of innovation-active employment is marginal. In other words, innovation active employment is more or less as evenly distributed on different sectors as employment in general. This common characteristic of large-city regions illustrate the breadth of regional knowledge bases in such regions, and the associated need and potential for building regional innovation systems that strengthen diversity-based knowledge dynamics.

Figure 7-5 Concentration of innovation active employment in Hordaland.

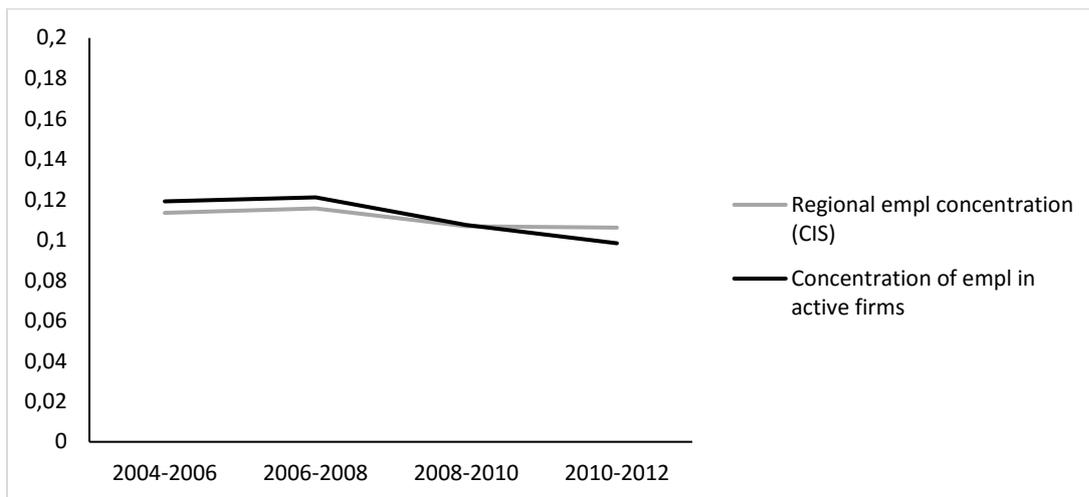
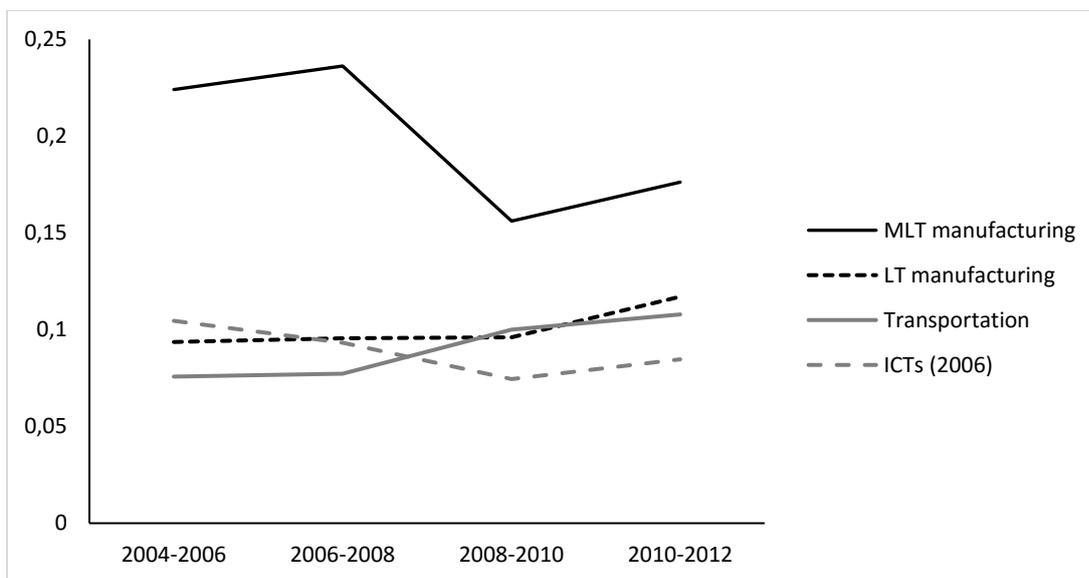


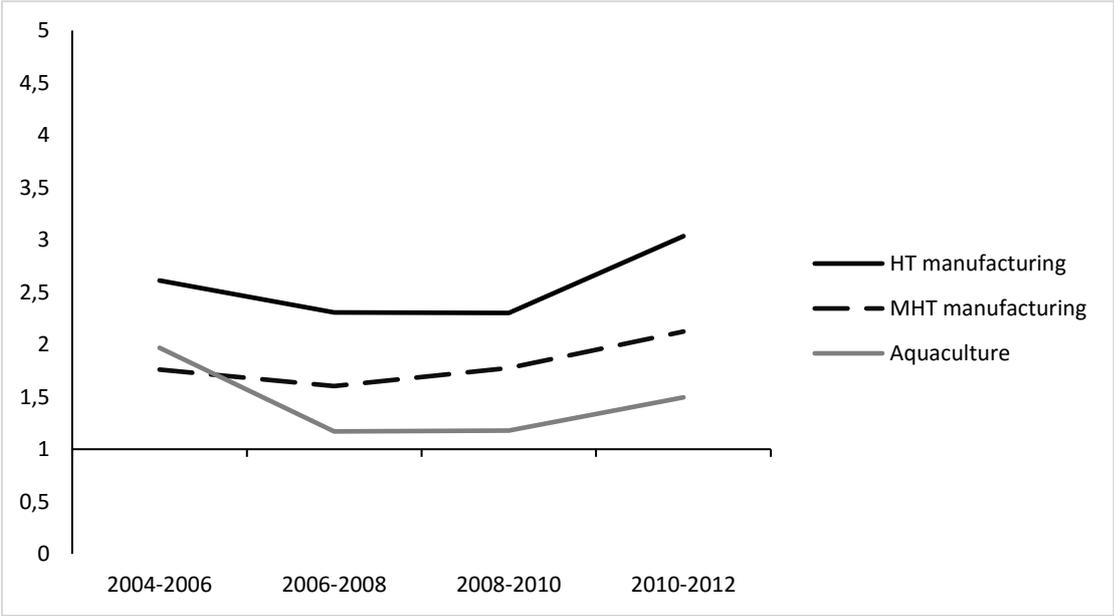
Figure 7-6 below shows that the largest contributor of innovation-active employment in Hordaland is the MLT manufacturing sector. At the end of the period, it accounted for 17 per cent of such employment, down from a peak of 23 in 2006-2008. LT manufacturing and transportation have slightly increased their contribution of active employment, whereas the contribution from the ICT sector decreased from 10 per cent at the beginning of the period to 8 per cent at the end of it.

Figure 7-6 Sector contribution to innovation-active employment in Hordaland. The three largest at the beginning and end of the period



Another illustration of regional diversity is that none of the three largest sectors contributed more to innovation activity than would be expected from their sizes. The comparatively smaller HT and MHT manufacturing sectors, by contrast, contributed at the end of the period between 2 and 3 times more. Notably, these commitment levels have been relatively stable. The aquaculture industry reduced its commitment to innovation in Hordaland from the first to the second part of the period, only to increase this commitment from the third to the fourth part.

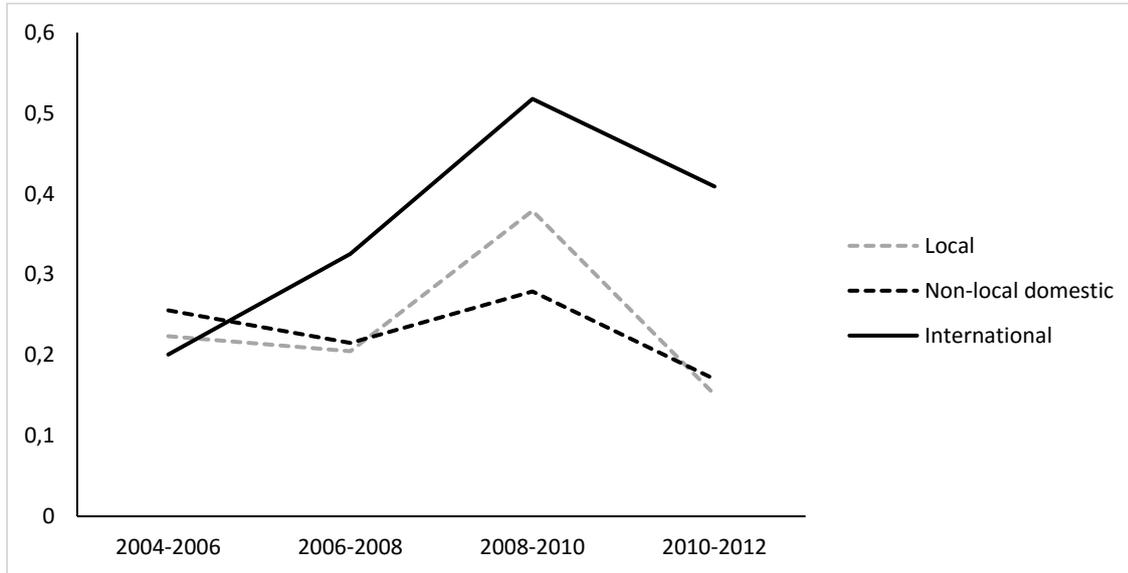
Figure 7-7 Sector commitment to innovation activity in Hordaland. *The three most committed at the beginning and end of the period*



7.4 The narrow definition of RIS: Local research system linkages

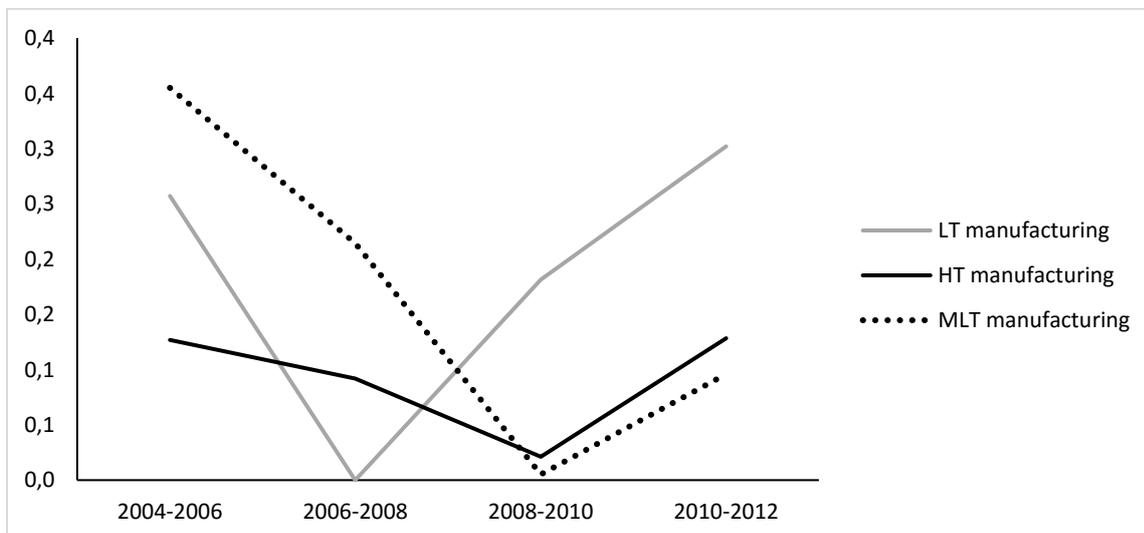
From Figure 7-8 below, it is evident that weakened linkages to international research system networks are paralleled by a strong increase in the concentration of such linkages. Local research system networks, by contrast, exhibited fluctuating yet somewhat lower concentration scores at the end of the period, compared to what was observed at the beginning. However, this is driven foremost by a decline in the overall level of research system collaboration during the two latest waves of the CIS.

Figure 7-8 Sector concentration of research system collaboration in Hordaland



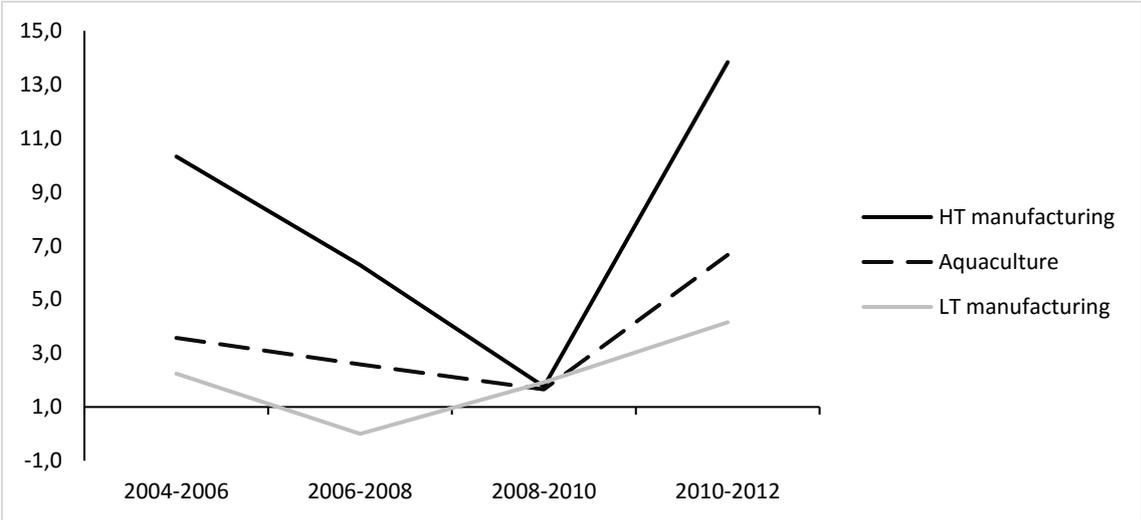
During the period considered, the LT manufacturing sector replaced the MLT manufacturing sector as the single largest participant in local research system collaboration. During the period 2006-2008 in which local research collaboration in Hordaland was at its peak (cf. Figure 7-1 and 7-2), the relative contribution from the three depicted sectors was moderate because the peak was driven by a large yet temporary contribution from the Technical & Scientific Services sector. At the end of the period, collaboration was again dominated by the LT manufacturing sector followed at distance by HT manufacturing and MLT manufacturing.

Figure 7-9 Sector contribution to research system collaboration in Hordaland. The three largest at the beginning and end of the period



The HT manufacturing sector is strongly over-represented in local research system collaboration, exhibiting at the end of the period a contribution to such networks that was almost 14 per cent higher than would be expected from its size. While this sector exhibit exceptionally strong period-to-period fluctuations, the LT manufacturing sector steadily increased its commitment to local research system collaboration during the later stages. The strong commitment of the aquaculture sector is also notable.

Figure 7-10 Sector commitment to research system collaboration in Hordaland. *The three most committed at the beginning and end of the period*



7.5 The broad definition of RIS: Local inter-firm linkages

No clear trends beyond period-to-period fluctuations are evident with respect to the concentration of industrial collaboration in Hordaland. Notably, and contrary to what is commonly the case in Norwegian VRI regions, the level of concentration is more or less equal at all geographical scales.

Figure 7-11 Sector concentration of industrial collaboration in Hordaland

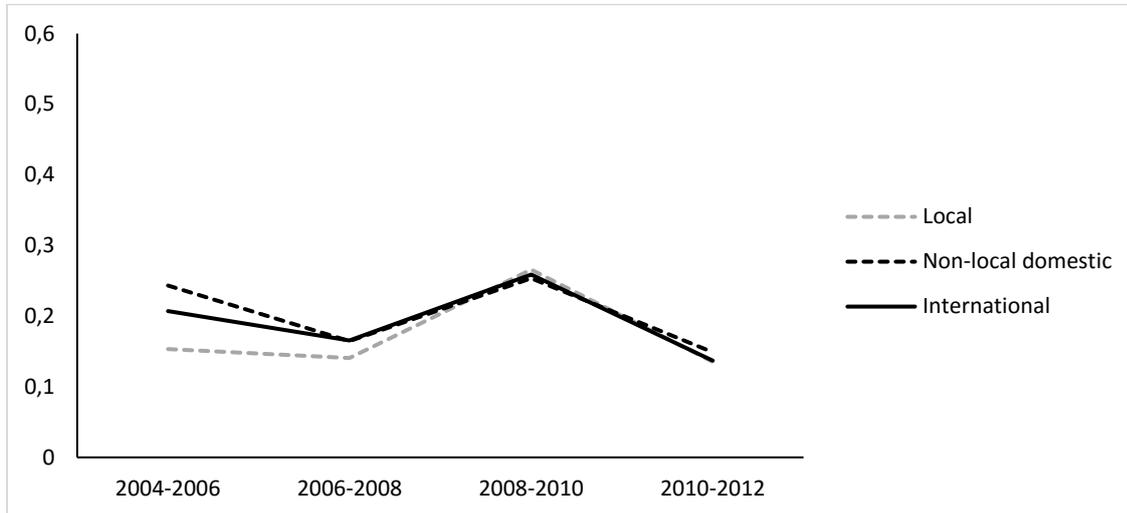
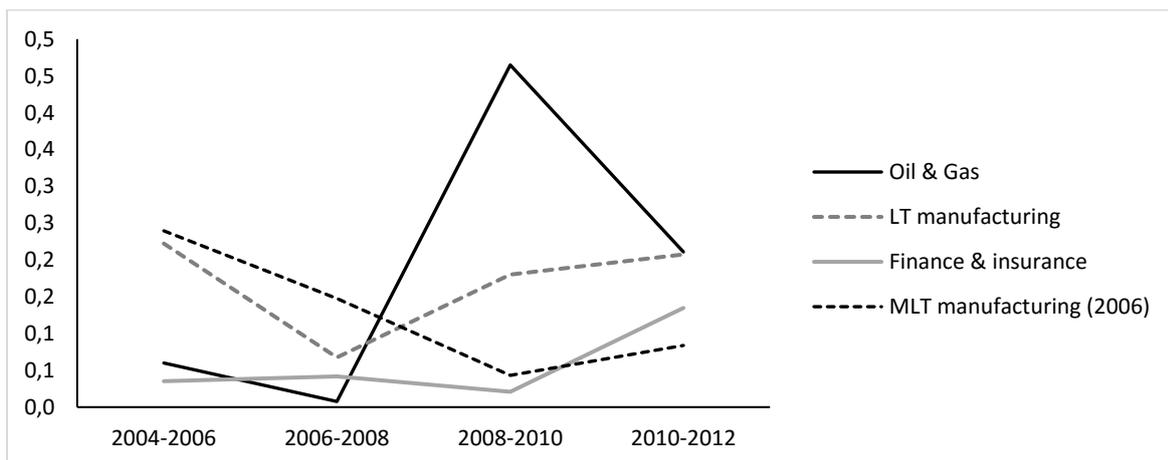


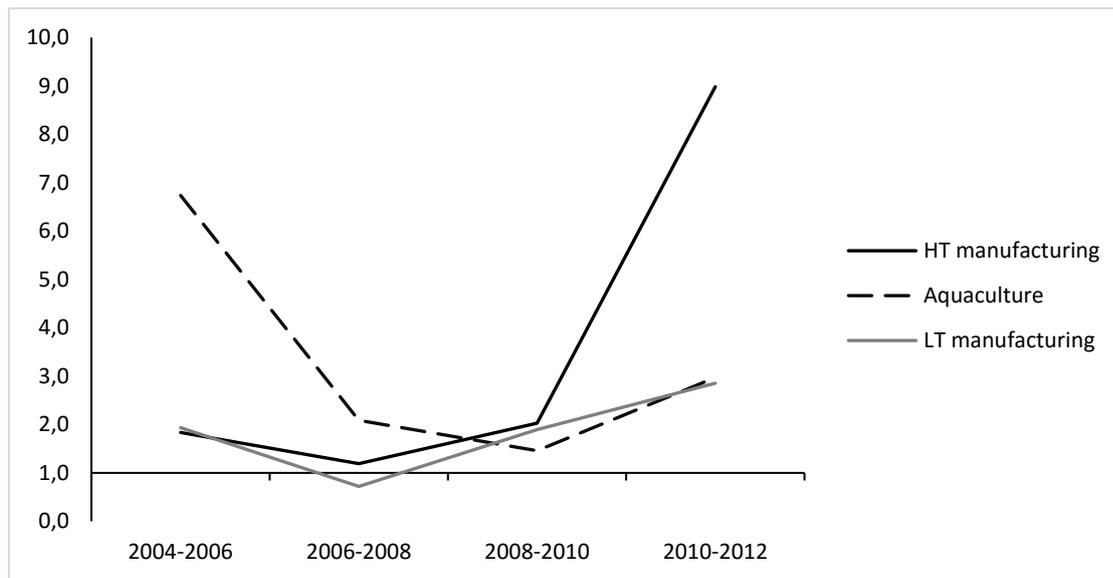
Figure 7-13 below indicate that the peak in concentration during the period 2008-2010 is driven by a strong increase in the contribution from the Oil & Gas sector, which by the end of the period had established itself as dominant in local industrial collaboration networks. This is highly notable, as the sector does not rank among the large contributors of innovation-active employment, nor does it rank among the top contributors to local research system collaboration. The contribution from MLT and LT manufacturing to local industrial collaboration, by contrast, reflect the contribution of these industries also to innovation activity in general and to research system collaboration in particular.

Figure 7-12 Sector contribution to local industrial collaboration in Hordaland. The three largest at the beginning and end of the period



While too small to rank among the largest contributors, the HT manufacturing sector strongly increased its commitment to local industrial collaboration during the later parts of the period. Increasing commitment is also exhibited by the LT manufacturing, while the aquaculture sector exhibit a substantially lower level of commitment at the end of the period than at the beginning.

Figure 7-13 Sector commitment to local industrial collaboration in Hordaland. The three largest at the beginning and end of the period



7.6 Summary

Hordaland exhibit strong employment performance in a relatively broad range of industries that are also cross-fertilizing each other through the regional labour market. Yet, it exhibits few clear-cut trends in key RIS indicators. The mobilisation of firms into development work that is the micro-foundation for RIS construction fluctuated through the period considered; with particularly strong performance during the early stages and indications of a negative trend towards the end of it. The proportions of innovation active employment that was involved in local research system collaboration and industrial collaboration also fluctuated, with some indications of a negative trend. A more clear-cut negative trend for international collaboration is evident for the period as a whole. When interpreted against the background of the relatively broad micro-foundations for RIS construction that exist in the region, these are development characteristics with unclear general implications that still suggest a networked regional innovation system has not emerged during the period.

8 Møre & Romsdal

8.1 Region overview

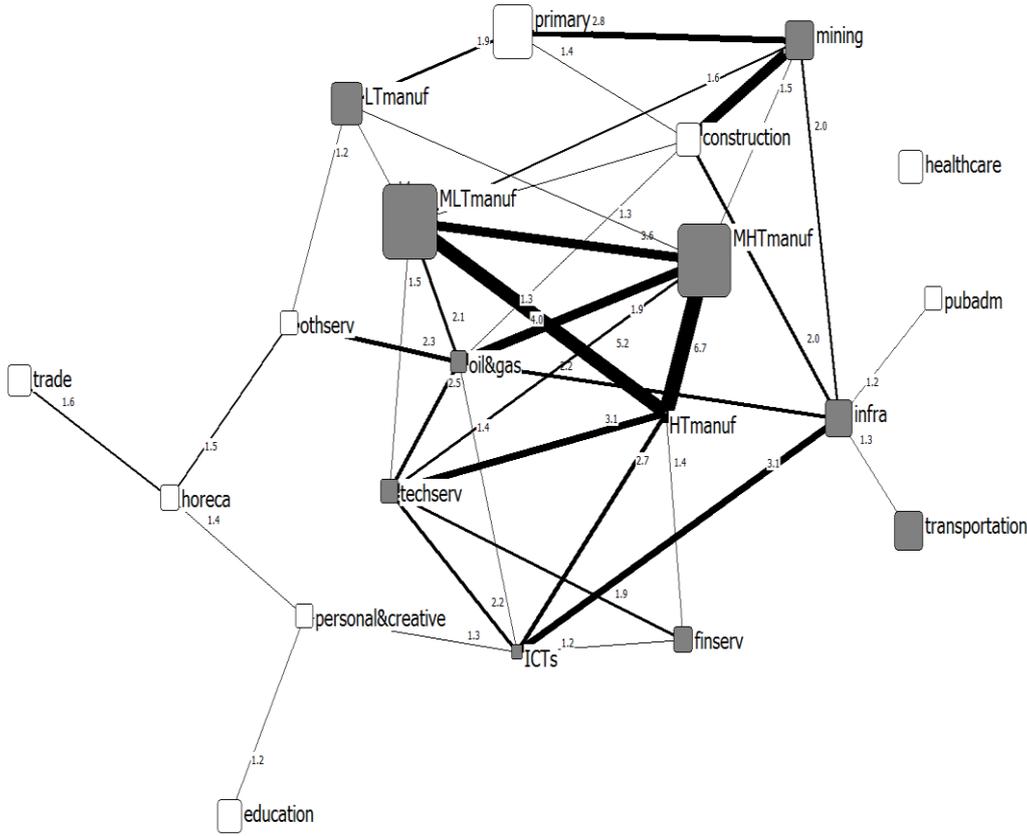
Møre & Romsdal accounted in 2012 for approximately 5 per cent on Norwegian employment, and experienced a healthy 7.5 per cent growth from 2006. It is highly specialised in all manufacturing groups except HT, in which employment declined dramatically; in the primary sectors and in mining & quarrying. Particularly strong sector-level growth is exhibited in Oil & Gas, and in the MHT manufacturing industries that are at the core of the regions' maritime technology cluster. Strong growth was also exhibited by the ICT sector, and by Technical & Scientific Services.

Table 8-1 Location quotients & growth rates, Møre & Romsdal. Sectors marked with grey are fully covered in the harmonized CIS sample

	Location quotients				Employment growth
	2006	2008	2010	2012	2006-2012
Primary	1,75	1,68	1,72	1,70	-20,10 %
Mining & Quarrying	1,59	1,45	1,24	1,16	-12,18 %
Oil & Gas	0,14	0,21	0,54	0,64	(801 %)
HT manufacturing	0,05	0,04	0,01	0,01	-75,86 %
MHT manufacturing	1,93	2,23	2,22	2,30	20,93 %
MLT manufacturing	2,36	2,26	2,41	2,36	-8,14 %
LT manufacturing	1,23	1,20	1,28	1,29	-7,72 %
Infrastructure	1,12	1,23	1,18	1,15	16,94 %
Construction	0,97	0,96	0,97	0,99	19,68 %
Trade	0,91	0,92	0,93	0,93	3,97 %
Transportation	1,20	1,27	1,28	1,19	-1,72 %
Horeca	0,83	0,82	0,84	0,77	-1,76 %
ICTs	0,36	0,37	0,38	0,41	31,09 %
Financial Services	0,76	0,75	0,79	0,76	4,80 %
Technical & Scientific services	0,59	0,67	0,64	0,67	40,05 %
Other services	0,66	0,63	0,68	0,71	20,01 %
Public administration	0,69	0,71	0,69	0,71	17,94 %
Education	0,96	0,94	0,94	0,97	8,70 %
Healthcare	1,02	1,02	1,01	1,03	11,87 %
Personal & Creative	0,70	0,72	0,70	0,71	13,98 %
Proportions of domestic employment & regional employment growth	5,04 %	5,03 %	5,03 %	5,00 %	7,47 %

From Figure 8-1, it is evident that the ICT and Technical & Scientific services sectors are part of a cluster of skill-related industries that are dominated by the large MLT (which include shipbuilding) and MHT (which include maritime equipment) industries of the region. The Oil & Gas sector that established itself in the region during the period emerges as strongly skill-related to the manufacturing and services cluster, in particular through labour linkages with the MHT manufacturing sector.

Figure 8-1 Skill-relatedness revealed by local labour market mobility in Møre & Romsdal, 2002-2012. Line thickness expresses the ratio of observed local mobility over expected mobility, i.e. the degree of revealed skill relatedness. Node size signifies location quotients. Grey nodes are sectors included in the innovation analysis. Only linkages where observed/expected > 1.1 are depicted



8.2 Baseline innovation profile

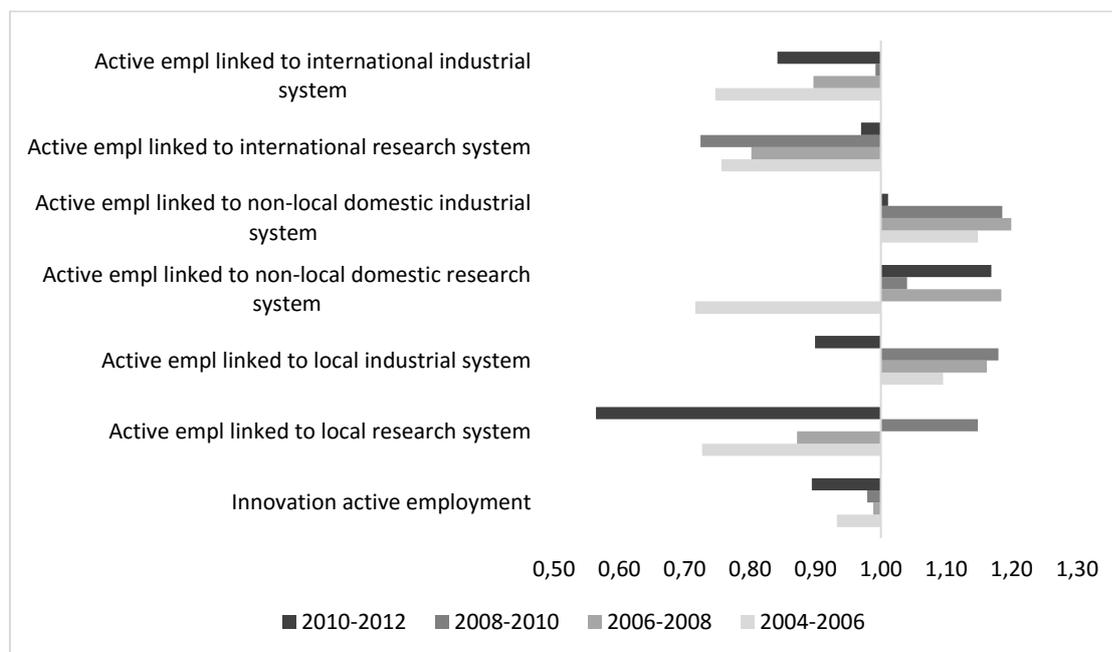
The first line in Table 8-1 below gives the number of establishments in the sample, i.e. the number of establishment in Møre & Romsdal that belong to enterprises sampled by the CIS. The second line gives the number of establishment that those sampled are meant to represent, i.e. the population size estimated based on sampling weights provided by Statistics Norway.

Table 8-2 Number of establishment-level observations

	CIS2006	CIS2008	CIS2010	CIS2012
Unweighted (sample)	600	618	633	649
Weighted (population)	1375	1220	1217	1207

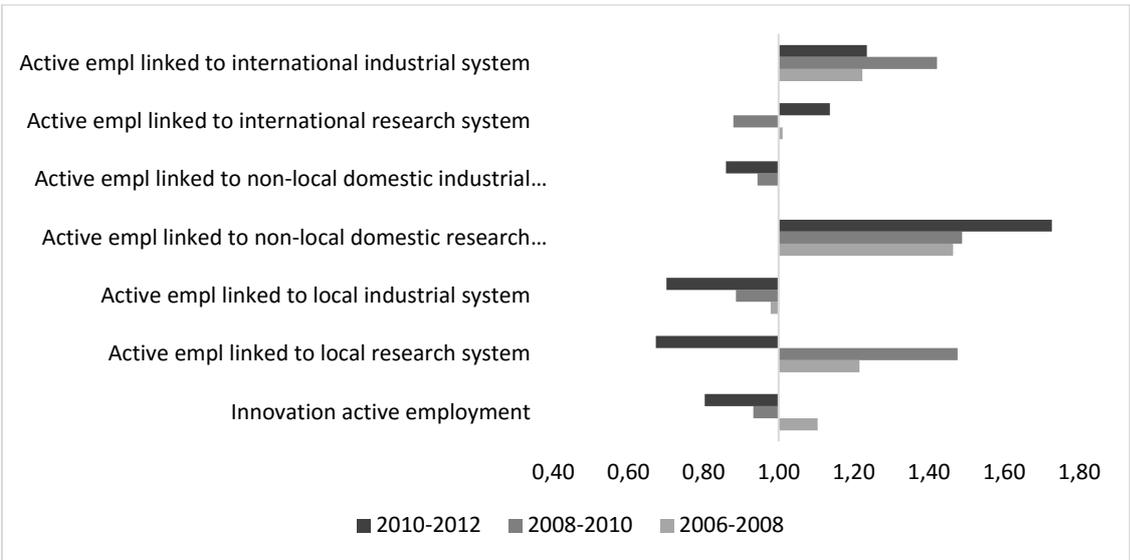
Compared to the (declining) national averages, Møre & Romsdal exhibited a decline in innovation-active employment during the period. With the exception of the period 2008-2010, a decline is also observed in the proportion of employment engaged in active firms that maintain local research system collaboration.

Figure 8-2 Innovation profile Møre & Romsdal, relative to Norway = 1



From Figure 8-3, it is evident that local research system collaboration was strengthened substantially during the two waves of the CIS that cover the years 2006-2010. However, it then declined sharply at the end of the period and reached levels well below those exhibited at the beginning of it. While strong compared to the national average, local industrial collaboration decreased steadily through the different waves of the CIS, while linkages to non-local domestic research institutions reached levels well above those exhibited by the region itself at the beginning of the period and in Norway as a whole.

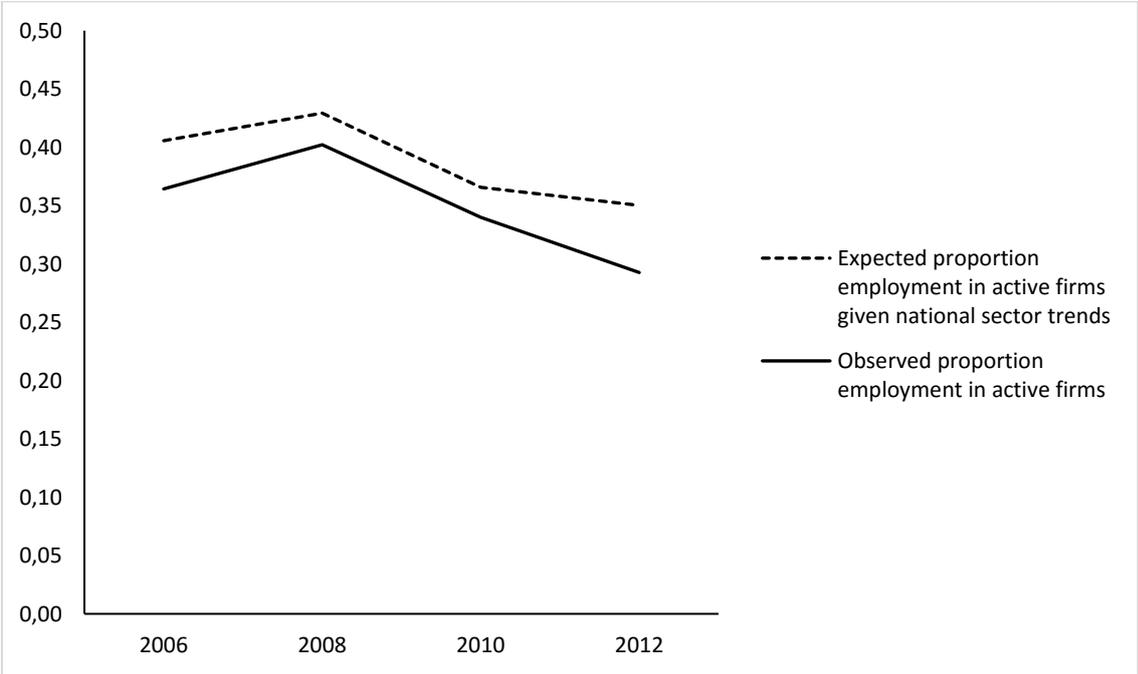
Figure 8-3 Innovation profile Møre & Romsdal, relative to region in 2006 = 1



8.3 The micro-foundations for RIS

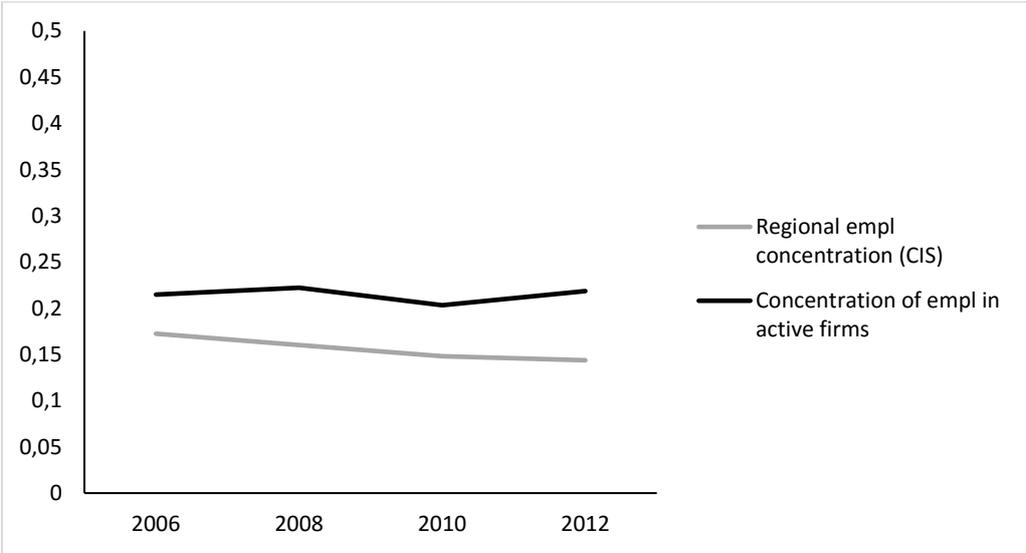
The proportion of employment occurring in innovation-active firms has consistently been somewhat below the levels that would be expected given the structural composition of the regional economy in Møre & Romsdal, and the gap increased at the end of the period.

Figure 8-4 Observed vs. expected innovation activity in Møre & Romsdal



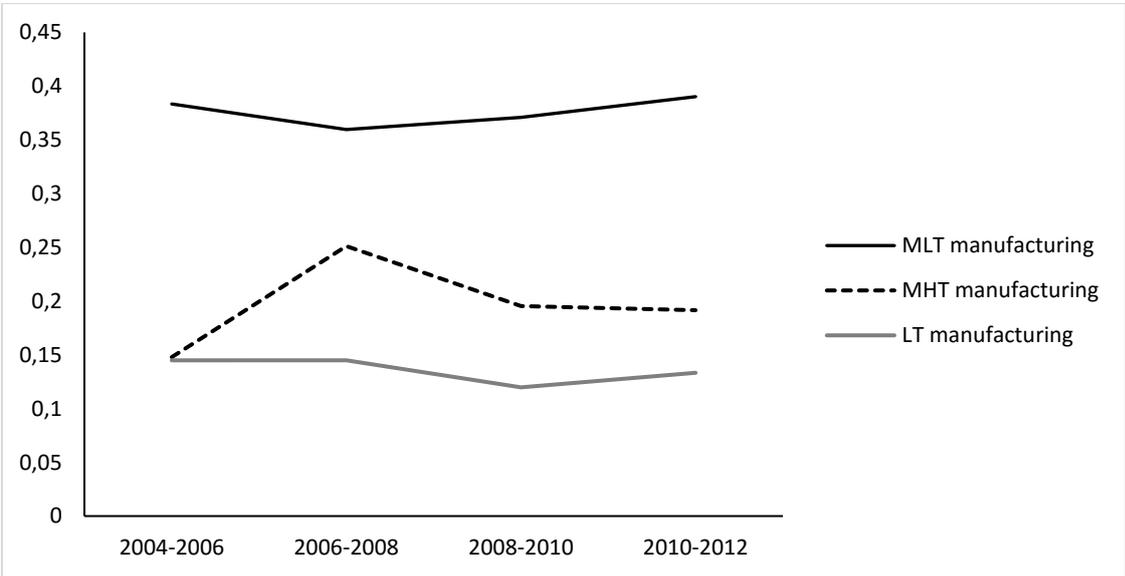
Weakened innovation activity levels are paralleled by increasing concentration of innovation-active employment, in spite of decreasing concentration of overall CIS employment concentration. Thus, while the employment base covered by the survey became slightly more diversified during the period, innovation activity became more specialised. To the extent that the patterns depicted at the end of the period in Figures 8-4 and 8-5 marks the beginning of a trend, this warrants dedicated policy attention.

Figure 8-5 Concentration of innovation active employment in Møre & Romsdal



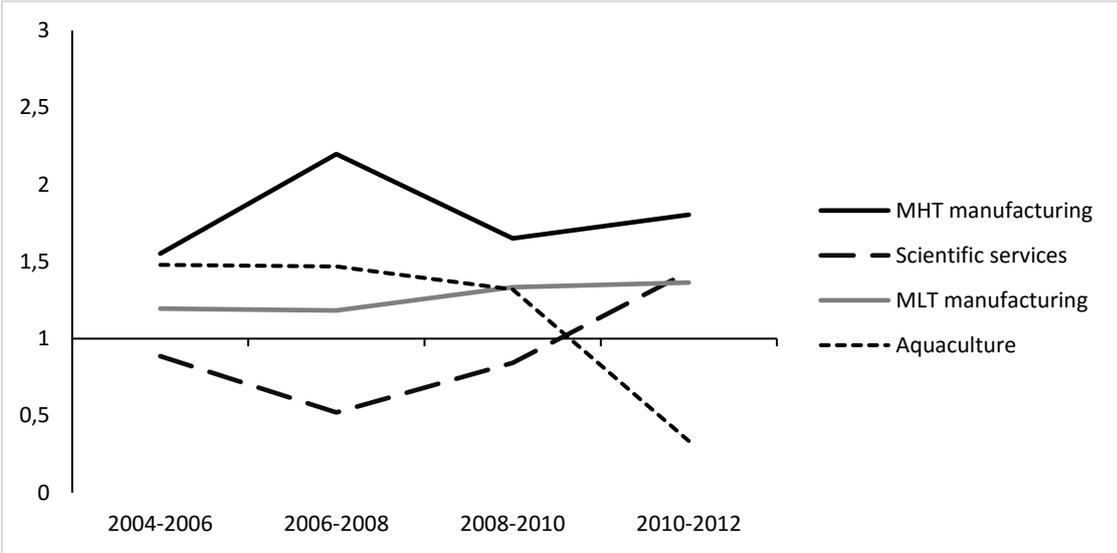
Given the strong maritime technology clusters of Møre & Romsdal, it is not surprising to find innovation activity dominated by the MLT manufacturing sector that include shipyards and the MHT manufacturing industry that include providers of specialised machinery and equipment. While MHT reduced its contribution to active employment from 25 per cent in 2006-2008 to 19 per cent in 2010-2012; MLT increased its contribution from 35 per cent to 39 per cent during the same period.

Figure 8-6 Sector contribution to innovation active employment in Møre & Romsdal. The three largest at the beginning and end of the period.



MLT and MHT manufacturing are also among the most committed to development work. Starting in 2006-2008, the Technical & Scientific Services sector that include providers of technical consultancy services and R&D services increased its commitment substantially. This sector is densely skill-related to the manufacturing base. The aquaculture sector, on the other hand, strongly reduced its commitment to regional innovation.

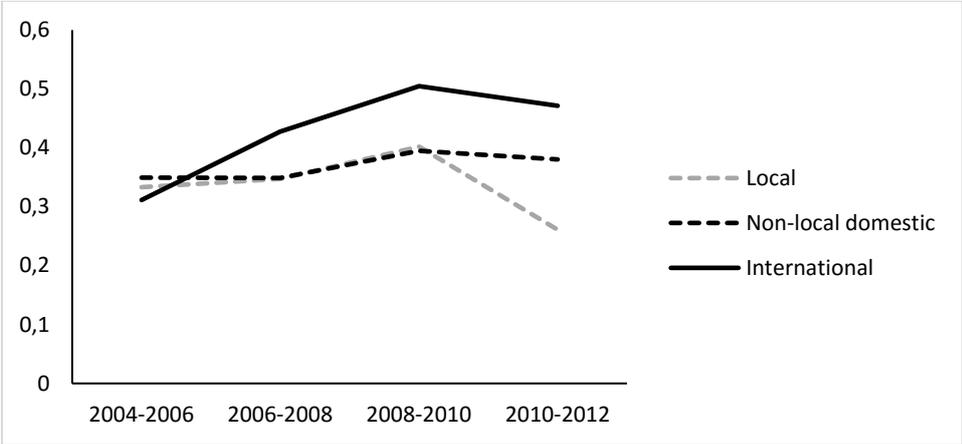
Figure 8-7 Sector commitment to innovation activity in Møre & Romsdal. The three most committed at the beginning and end of the period.



8.4 The narrow definition of RIS: Local research system linkages

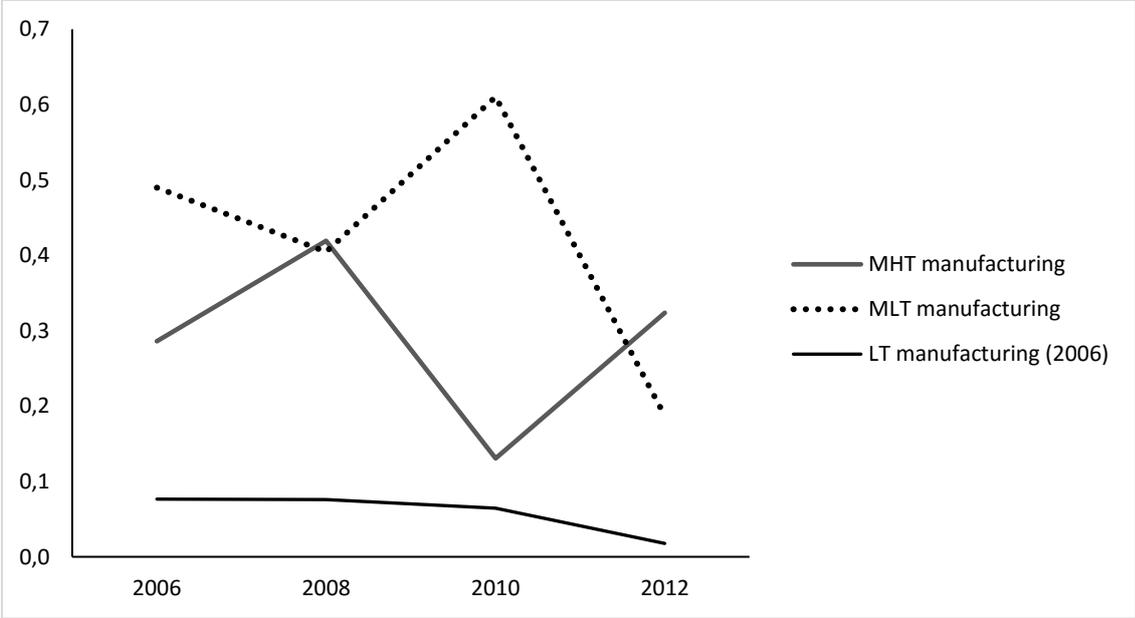
During the period considered, the international research system linkages of Møre & Romsdal became increasingly concentrated. Non-local research system linkages were strengthened and became more specialised during the period, whereas local research system linkages weakened and became less specialised as a result.

Figure 8-8 Sector concentration of research system collaboration in Møre & Romsdal



This drop in concentration must be seen in light of the reduced contribution to local research system collaboration from the MLT manufacturing sector. Moreover, the period 2010-2012 also saw the entry of an additional sector that came to contribute almost 30 per cent of this employment type. Due to the low number of observations in this sector, data cannot be reported.

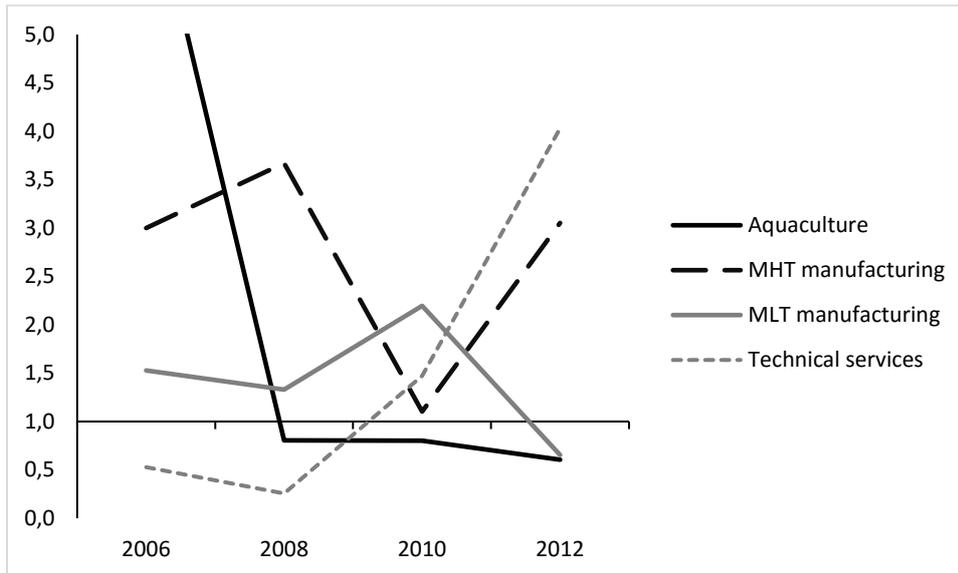
Figure 8-9 Sector contribution to local research system collaboration in Møre & Romsdal. One sector excluded due to data disclosure reasons.



From figure 8-10 below, it is evident that the reduced commitment of the Aquaculture industry to innovation in general is paralleled by a strong decrease in the commitment of active firms to local research system collaboration. Moreover, it is evident that the reduction in contribution from the MLT manufacturing sector described in Figure 8-9 above is not attributable to a reduction in the size of the sector, but reflect a strong reduction in its commitment to local research system collaboration. The

commitment of the MHT sector declined from 2006-2008 to 2008-2010, but reached at the end of the period levels comparable to those observed at the beginning of it. Technical and Scientific services steadily, and radically, increased its commitment to local research system collaboration during the period.

Figure 8-10 Sector commitment to local research system collaboration in Møre & Romsdal. *The three most committed at the beginning of the period, and two out of three most committed at the end of the period. A third strongly committed sector at the end of the period is excluded due to data disclosure concerns.*

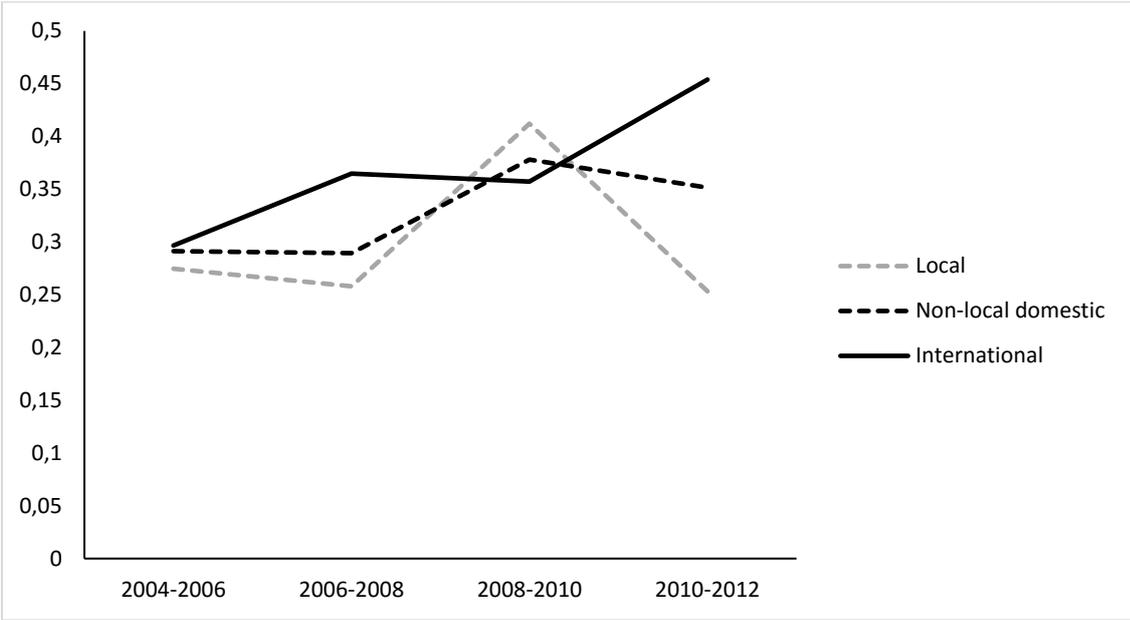


This picture of reduced interaction between local science system institutions and local manufacturing industries, and increased interaction between the former institutions and the Technical & Scientific Services sector, suggests that the latter may have positioned itself at the intersection between local science institutions and the manufacturing firms that dominate local innovation-active employment. This is consistent with increasing commitment from the Technical & Scientific Services sector also to local industrial collaboration (cf. Figure 8-14 below).

8.5 The broad definition of RIS: Local inter-firm linkages

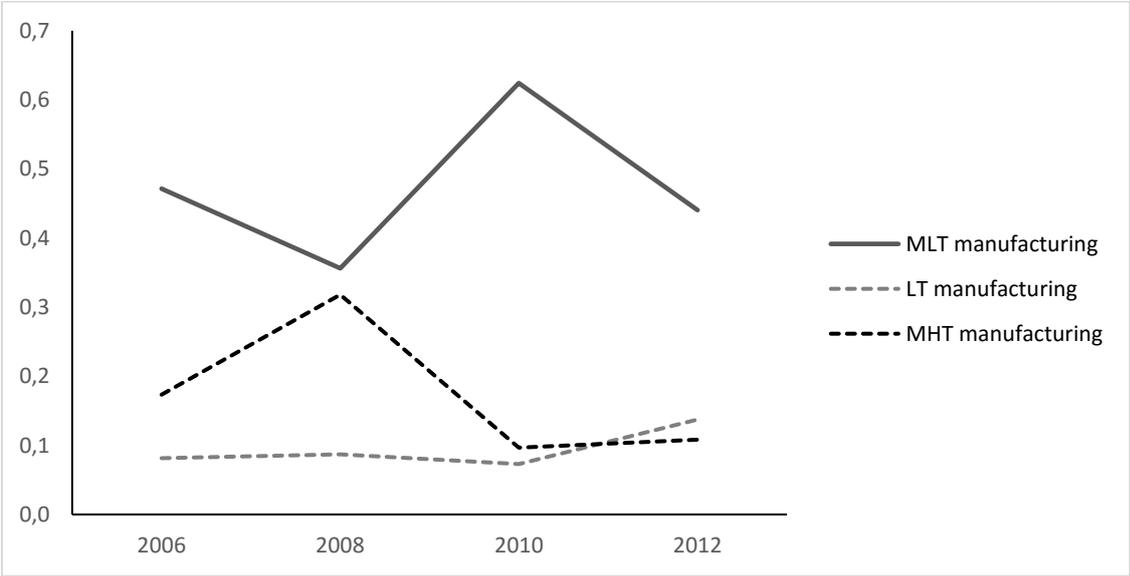
Møre & Romsdal experienced a sharp increase in local industrial collaboration from 2006-2008 to 2008-2010, and then a sharp decline from 2008-2010 to 2010-2012. Because this was driven by a temporary increase in the contribution of MLT manufacturing (cf. Figure 8-12), the concentration of local industrial linkages first increased and then decreased as MLT sector reduced its commitment.

Figure 8-11 Sector concentration of industrial collaboration in Møre & Romsdal



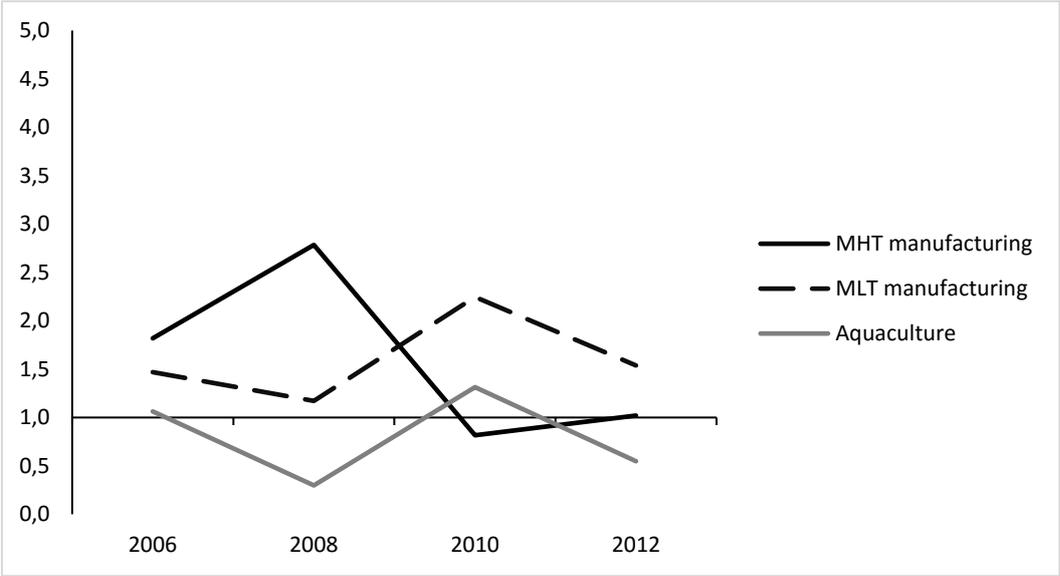
MLT manufacturing was the largest single contributor to local industrial collaboration throughout the period. MHT manufacturing reduced its commitment to local collaboration, while LT manufacturing increased it slightly.

Figure 8-12 Sector contribution to local industrial collaboration in Møre & Romsdal. *The dominant sectors at the beginning and end of the period. One sector is excluded due to data disclosure reasons.*



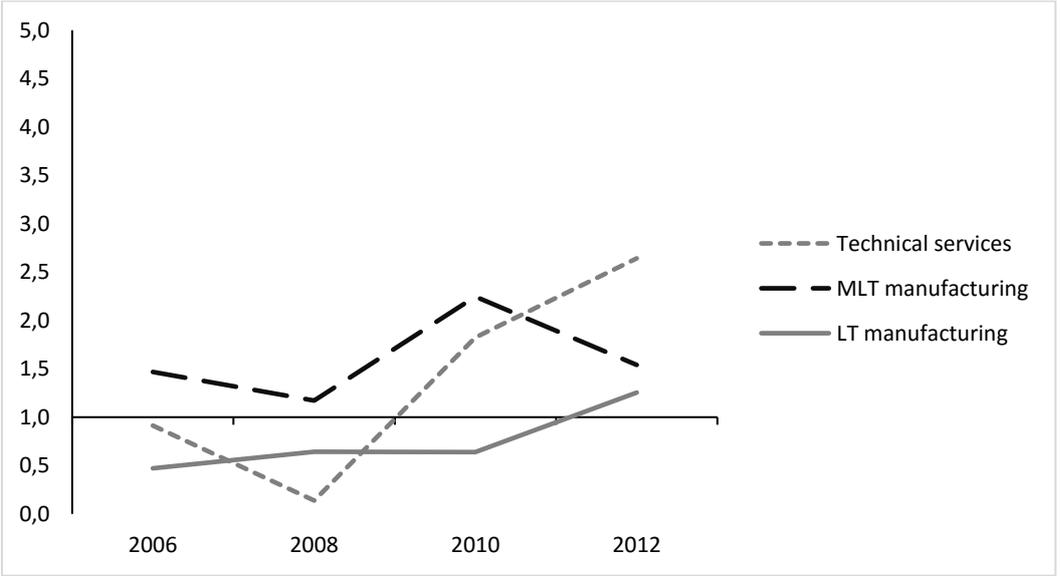
The most notable pattern in Møre & Romsdal is structural change in the composition of firms that are committed to local industrial collaboration. At the beginning of the period, a particularly high degree of commitment in MHT and MLT manufacturing industries was observed. The third most committed sector at the beginning of the period, aquaculture, contributed only 1,6 times more to such collaboration than would be expected from its size. During the period, a sharp decrease in the commitment of MHT manufacturing was paralleled by a reduction in the commitment also of the aquaculture industry.

Figure 8-13 Sector commitment to local industrial collaboration in Møre & Romsdal. The three most committed at the beginning of the period



Thus, only the MLT manufacturing sector that include shipyards remained among the three most committed at the end of the period. At the same time, a sharp and steady increase in the commitment of Technical & Scientific Services was observed. This sector contributed at the end of the period 2.64 times more to local industrial collaboration than would be expected from its size. Keeping in mind that this sector also contributed 4 times more to research system collaboration than would be expected from its size, this suggests that it has positioned itself as a gatekeeper that link industrial firms to science system institutions.

Figure 8-14 Sector commitment to local industrial collaboration in Møre & Romsdal. The three most committed at the end of the period



8.6 Summary

During the period, Møre & Romsdal strengthened its specialisation in the MHT manufacturing industries that include providers of advanced maritime equipment. Particularly strong employment growth was also exhibited by the ICT and Technical & Scientific Services industries, which are strongly skill-related with each other and the larger manufacturing complex of the region.

Innovation activity remained below the levels expected given the sector composition of the region and national industry trends. Compared both to the region itself and to the national average, it exhibited a particularly distinct decline during the later stages of the period, in which the sector concentration of active employment increased in spite of a reduction in the contribution and commitment of the fast-growing and large MHT manufacturing industry.

Local research system collaboration was strengthened during the years 2006-2008, before it started to decline and mirror the trend of consistently decreasing local industrial collaboration. Non-local research system collaboration, by contrast, was strengthened substantially. This is clearly consistent with development towards a regionalized national innovation system, rather than a regional networked innovation system. Still, the growth in commitment from the Technical & Scientific services sector to both types of local networks is notable.

9 Nordland

9.1 Region overview

The VRI region of Nordland accounted in 2012 for approximately 4.5 per cent of Norwegian employment. Beyond exhibiting over-representation of employment in public administration & defence, healthcare and education, it is specialised in primary industries, mining & quarrying, construction and infrastructure, and in LT manufacturing. During the period, it exhibited a very moderate 3.12 per cent overall employment growth. This growth was particularly strong in the Construction industry, in Scientific and Technical Services, and in Mining & Quarrying. By contrast, HT and MHT industries align with the primary industrial sector in exhibiting substantial declines in employment. Activity in the Oil & Gas sector is very limited.

Table 9-1 Location quotients & growth rates, Nordland. Sectors marked with grey are fully covered in the harmonized CIS sample

	Location quotients				Employment growth
	2006	2008	2010	2012	2006-2012
Primary	2,01	2,05	2,07	2,13	-16,24 %
Mining & Quarrying	2,28	2,57	2,33	2,73	38,50 %
Oil & Gas	0,00	0,00	0,00	0,01	(1900 %)
HT manufacturing	0,21	0,75	0,69	0,07	-71,20 %
MHT manufacturing	0,70	0,76	0,79	0,61	-14,35 %
MLT manufacturing	0,71	0,74	0,81	0,82	2,42 %
LT manufacturing	1,18	1,18	1,25	1,31	-7,39 %
Infrastructure	1,47	1,49	1,54	1,60	19,38 %
Construction	1,03	1,08	1,09	1,12	21,51 %
Trade	0,84	0,86	0,88	0,89	2,29 %
Transportation	1,39	1,36	1,25	1,32	-9,96 %
Horeca	0,93	0,94	0,96	0,99	8,03 %
ICTs	0,46	0,44	0,43	0,43	2,40 %
Financial Services	0,72	0,68	0,66	0,66	-7,31 %
Technical & Scientific services	0,55	0,55	0,55	0,54	17,74 %
Other services	0,64	0,60	0,58	0,59	-1,18 %
Public administration	1,26	1,24	1,10	1,10	-2,51 %
Education	1,18	1,17	1,17	1,16	2,67 %
Healthcare	1,14	1,16	1,19	1,19	10,25 %
Personal & Creative	0,79	0,78	0,81	0,81	11,35 %
Region share of domestic employment & region employment growth	4,66 %	4,57 %	4,46 %	4,43 %	3,12 %

9.2 Baseline innovation profile

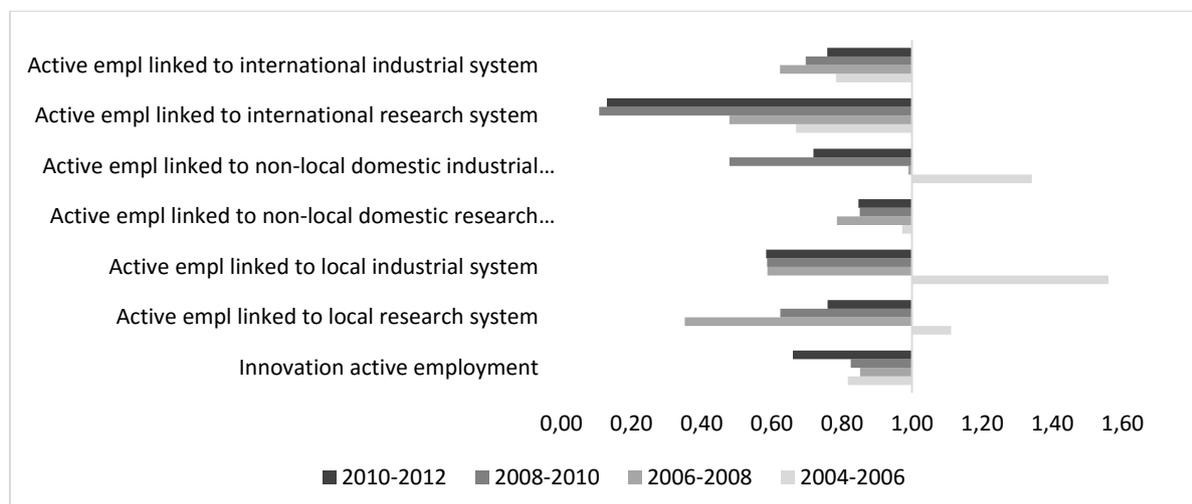
The first line in Table 9-2 below gives the number of establishments in the sample, i.e. the number of establishment in Nordland that belong to enterprises sampled by the CIS. The second line gives the number of establishment that those sampled are meant to represent, i.e. the population size estimated based on sampling weights provided by Statistics Norway.

Table 9-2 Number of establishment-level observations

	CIS2006	CIS2008	CIS2010	CIS2012
Unweighted (sample)	475	472	473	478
Weighted (population)	1000	924	868	868

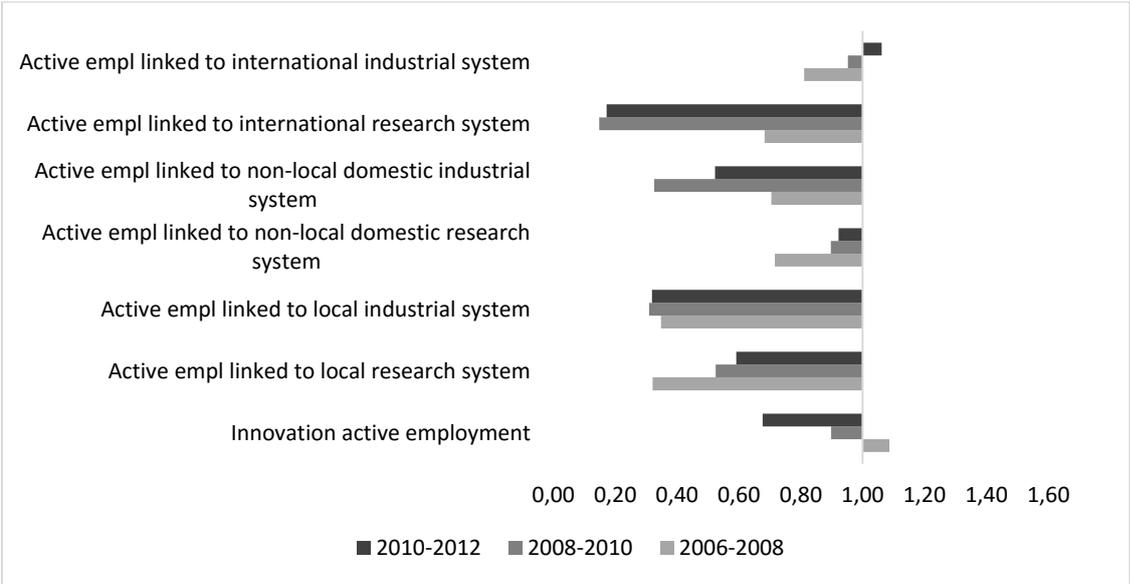
Both Figure 9-2 and Figure 9-3 demonstrates that the micro-foundations for RIS construction have weakened during the period considered. In particular during the two most recent waves of the CIS, the proportion of employment engaged in innovation activity declined compared to the national average and compared to the region itself in 2004-2006.

Figure 9-2 Innovation profile Nordland, relative to Norway = 1



At the beginning of the period, the trend in local research system collaboration was negative. During the two later stages, levels recovered somewhat. Still, local research system collaboration was in 2010-2012 only 59 per cent of the level exhibited at the beginning of the period, and 76 per cent of the national average. Indication of positive trends during the later stages of the period are also found for non-local domestic research collaboration, and for international industrial collaboration; yet, increases are from levels well below those exhibited by the region in 2004-2006 and those exhibited by Norwegian industry more generally.

Figure 9-3 Innovation profile Nordland, relative to region in 2006 = 1



9.3 The micro-foundations for RIS

Innovation activity in Nordland has consistently been below the levels that would be expected given the industrial structure of the region and national trends; and the gap increased at the end of the period. This warrants dedicated policy attention.

Figure 9-4 Observed vs. expected innovation activity in Nordland.

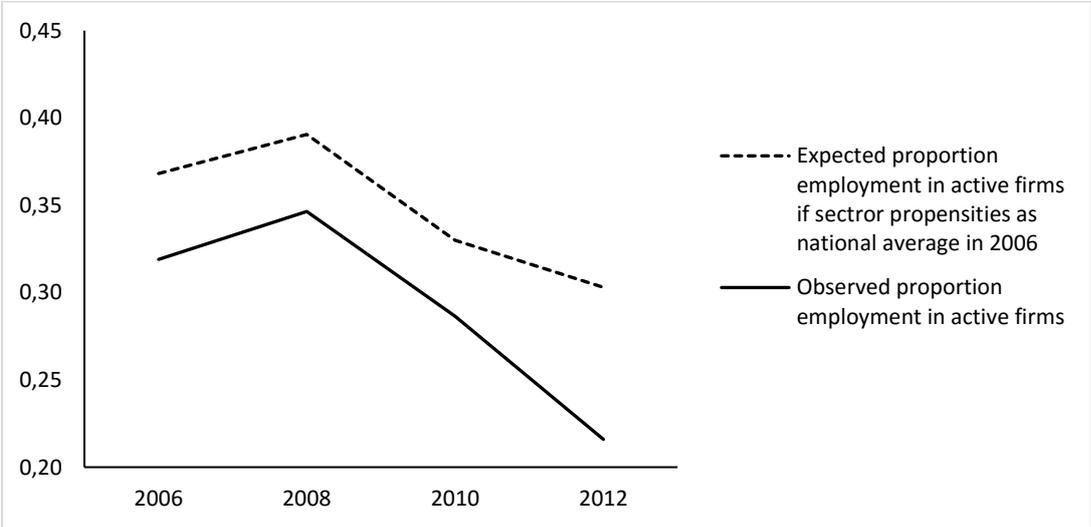
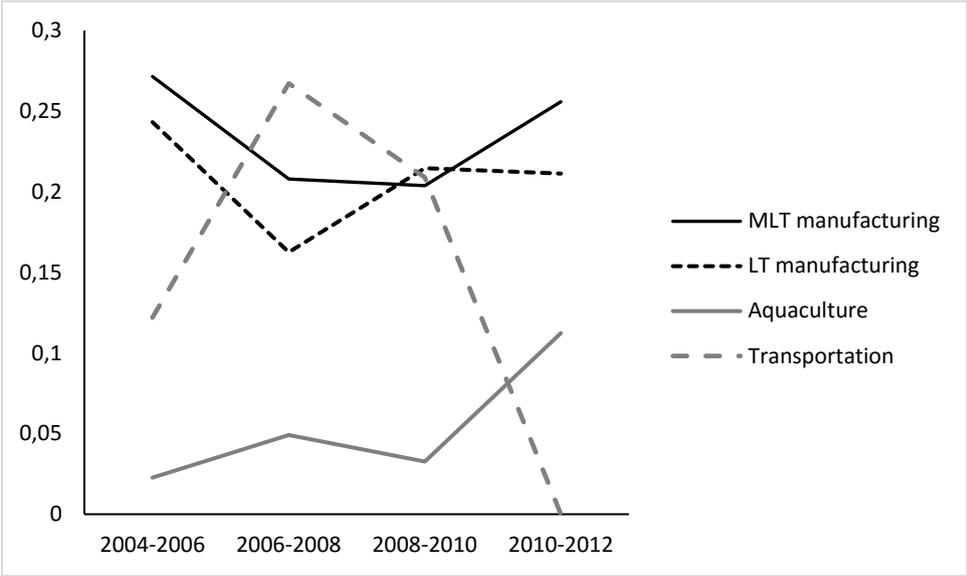


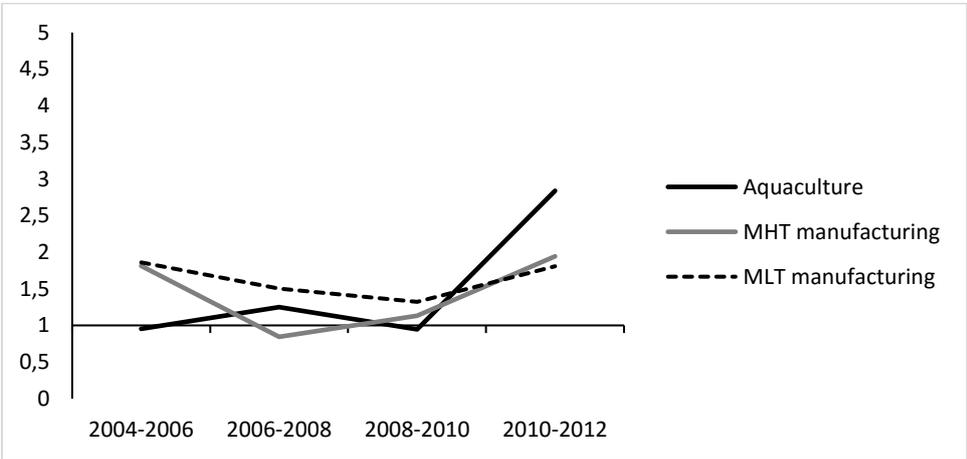
Figure 9-6 shows that the transportation sector, which in 2006-2008 and 2008-2010 accounted for 27 and 21 per cent respectively of all innovation active employment, contributed nothing in 2010-2012. This is paralleled by a relative increase in the contribution from the MLT manufacturing sector during the last phase. The contribution from the aquaculture sector increased strongly during the period.

Figure 9-5 Sector contribution to innovation active employment in Nordland. *The three largest at the beginning and end of the period*



The MLT and MHT manufacturing sectors that account for the largest contributions are also among the most committed. The commitment of both where reduced somewhat during the subsequent rounds of the CIS, but increased again at the end of the period when also the commitment of the aquaculture sector increased substantially. The most committed sector at the end of the period cannot be reported due to data disclosure concerns.

Figure 9-6 Sector commitment to innovation activity in Nordland. *Two out of the three most committed at the beginning and end of the period of the period. Data disclosure rules prohibit reporting the third sector.*



9.4 The narrow defintion of RIS: Local research system linkages

Concentration scores that fluctuate between 0.22 and 0.28 indicate that local research linkages in Nordland are not particularly specialised, given the size of the region. Non-local domestic research system linkages exhibit are at the end of the period less concentrated than local ones, while international linkages towards the end of the period became strongly dominated by a limited number of industrial sectors.

Figure 9-7 Sector concentration of research system collaboration in Nordland

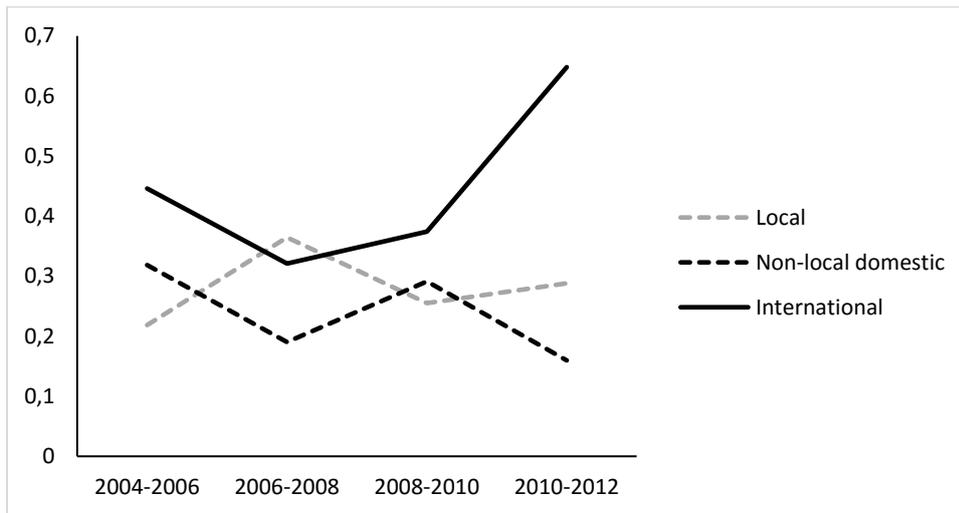
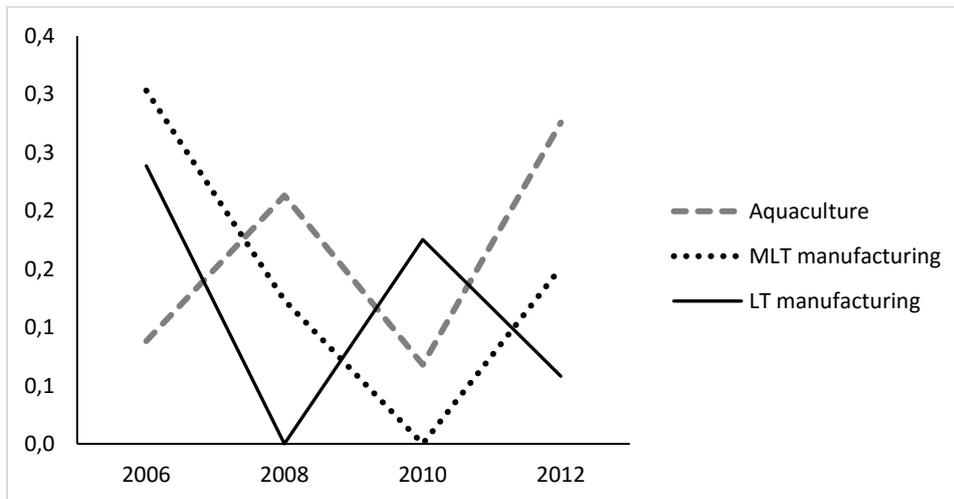


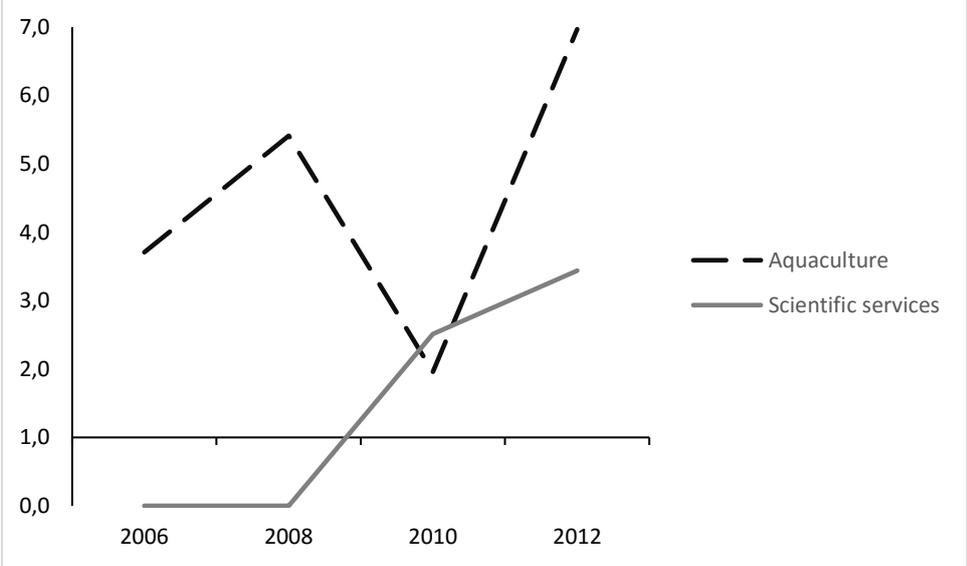
Figure 9-9 below shows that the commitment of dominant industries to research system in Nordland is exceptionally volatile. Strong period-to-period fluctuations indicate that a limited number of firms is engaged in such collaboration, and that it occurs on a non-systematic, project-to-project basis. Among the top-three contributors, the most stable is the aquaculture industry that contributed to research system networks during all phases of the period.

Figure 9-8 Sector contribution to local research system collaboration in Nordland. *The three largest at the beginning and end of the period. Data disclosure rules prohibit reporting of two large contributing sectors.*



The aquaculture industry is also highly committed, and contributed in 2010-2012 almost 7 times as much to research system collaboration as would be expected from its size. Notably, and similar to what was witnessed in Møre & Romsdal, the Technical & Scientific Services sector has during the last two phases of the period established itself as one of the most committed to interaction with local research system institutions.

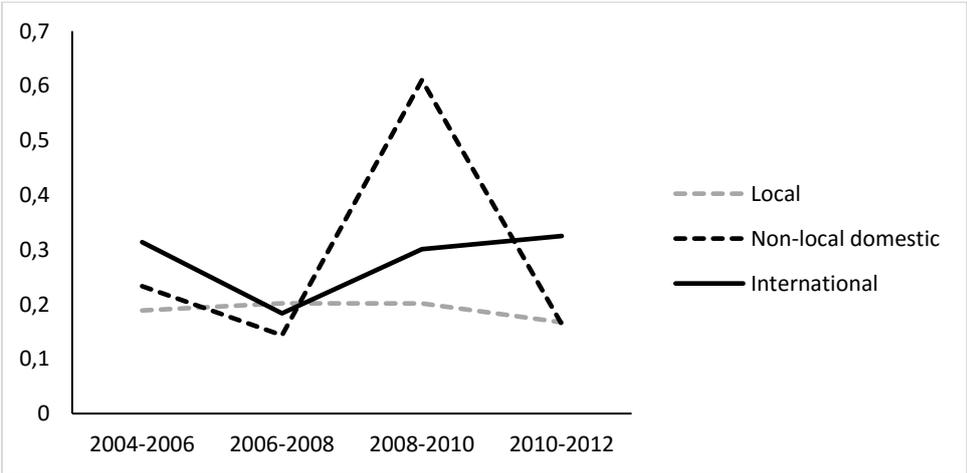
Figure 9-9 Sector commitment to local research system collaboration in Nordland. *Two sectors that were highly committed at the beginning or/and at end of the period have been excluded for data disclosure reasons.*



9.5 The broad definition of RIS: Local inter-firm linkages

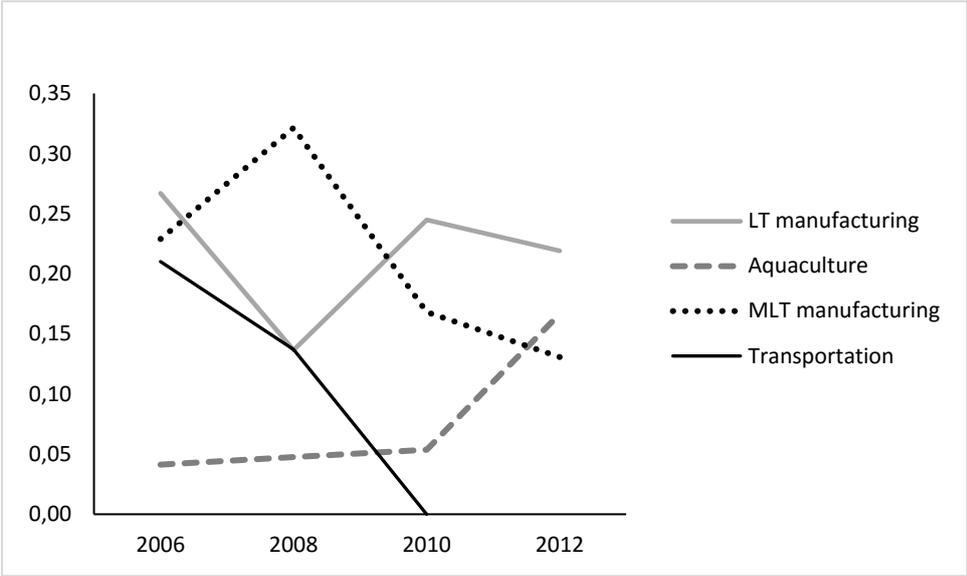
Non-local domestic industrial linkages exhibit concentration scores that have been fluctuation during the period, and peaked in 2008-2010 when the overall level of such collaboration was particularly low (cf. Figure 9-2 and Figure 9-3). In parallel with the positive overall trend for international linkages, these have also become more specialised during the later parts of the period. The exceptionally low (given the size of the region) concentration levels exhibited for local linkages reflect the poor performance of Nordland in this respect.

Figure 9-10 Sector concentration of industrial collaboration in Nordland



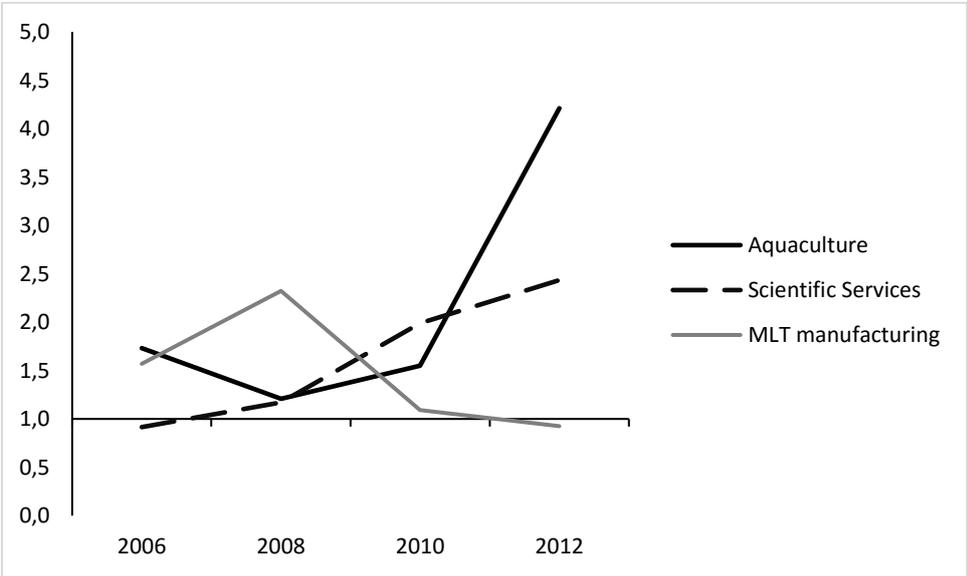
Local industrial collaboration in Nordland is at the end of the period dominated by LT manufacturing and aquaculture, followed closely by MLT manufacturing. Notably, the relative contribution from the latter sector, and from the transportation sector, was reduced substantially during the period, while the relative contribution from the aquaculture sector increased from 4 per cent in 2004-2006 to 17 per cent in 2010-2012.

Figure 9-11 Sector contribution to local industrial collaboration in Nordland. The three largest at the beginning and end of the period.



The commitment of the Aquaculture sector and the commitment of the Technical & Scientific Services sector increased substantially, while the MLT manufacturing sector reduced its commitment to levels below what would be expected from its size. The identity of the third most committed sector at the end of the period cannot be reported for data disclosure reasons.

Figure 9-12 Sector commitment to local industrial collaboration in Nordland. The three largest at the beginning and end of the period. Data disclosure rules prohibit reporting of one highly committed sector.



9.6 Summary

In Nordland, employment is over-represented in primary industries, mining & quarrying, construction and infrastructure, and in LT manufacturing. It strengthened its specialisation in these industries during a period in which mobility between them point to strong skill-relatedness, and exhibited a weak overall employment growth.

The performance of Nordland is poor on all RIS indicators. The proportion of employment occurring in active firms decreased during the period, and what was initially a substantial gap between expected and observed rates grew further. This warrants dedicated policy attention. The proportion of active employment occurring in firms with a local research system linkage were consistently below the national averages, yet, recovered somewhat in 2010-2012; while local industrial collaboration consolidated at a level well below the national average and the level exhibited by the region itself at the beginning of the period. Sector contributions and commitment fluctuated strongly.

The exception to this is stable increases in the commitment of the Technical & Scientific Services to local industrial collaboration, and increasing contributions from the Aquaculture industry to innovation activity that is mirrored in increasing contributions and commitment to local research system and industrial collaboration. These are early indications of development towards a specialised aquaculture innovation network that are particularly interesting in light of the reduced commitment of the industry to innovation and networking in other Norwegian VRI regions.

10 Oslo & Akershus

10.1 Region overview

The Capital region of Oslo & Akershus exhibit particularly strong location quotients for knowledge intensive business services, ICTs and public administration. Employment growth in the region as a whole was an impressive 11.2 per cent during the period, with the Technical & Scientific Services, Construction, ICT, Oil & Gas and infrastructure sectors exhibiting particularly high rates.

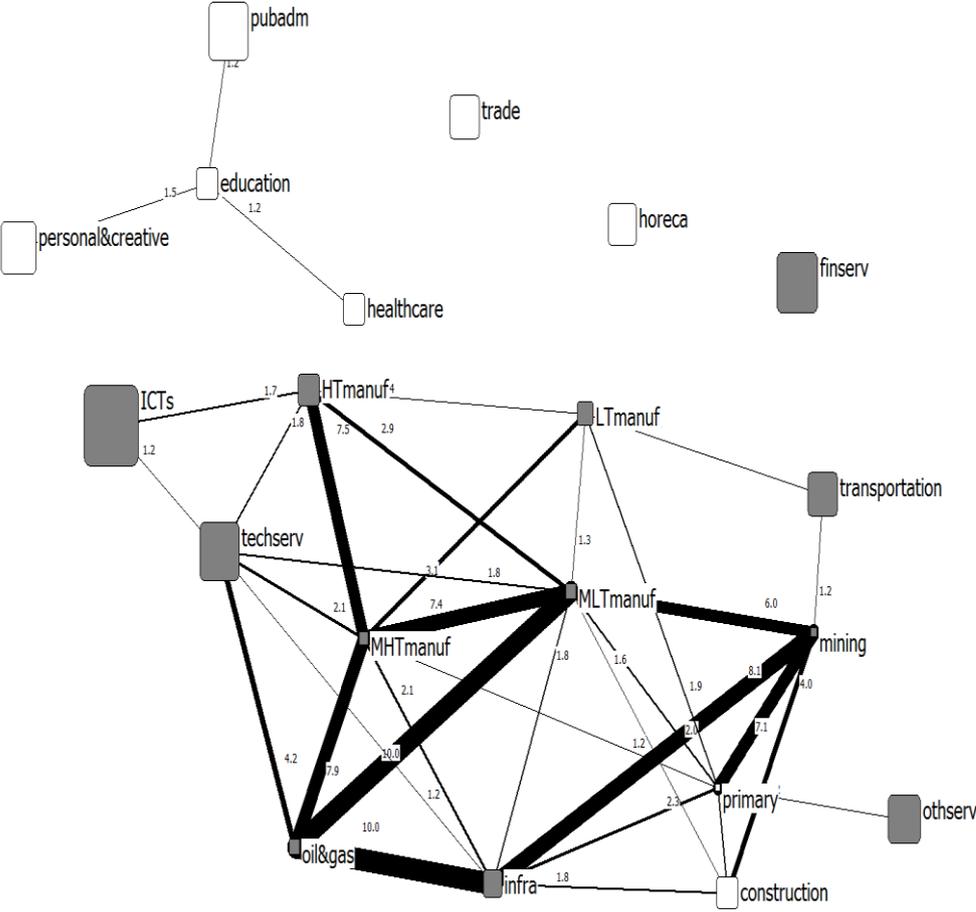
Table 10-1 Location quotients & growth rates, Oslo & Akershus. Sectors marked with grey are fully covered in the harmonized CIS sample

	Location quotients				Employment growth
	2006	2008	2010	2012	2006-2012
Primary	0,18	0,18	0,16	0,16	-21,62 %
Mining & Quarrying	0,34	0,36	0,27	0,23	-16,38 %
Oil & Gas	0,23	0,41	0,36	0,35	207,45 %
HT manufacturing	1,08	0,87	0,82	0,82	-28,59 %
MHT manufacturing	0,43	0,41	0,35	0,34	-15,57 %
MLT manufacturing	0,38	0,37	0,38	0,39	-2,32 %
LT manufacturing	0,57	0,57	0,55	0,56	-9,97 %
Infrastructure	0,63	0,67	0,71	0,71	33,72 %
Construction	0,79	0,78	0,80	0,79	21,49 %
Trade	1,15	1,12	1,10	1,11	1,27 %
Transportation	1,17	1,17	1,14	1,12	-2,57 %
Horeca	1,04	1,02	1,03	1,07	12,94 %
Information & Communication (ICTs)	2,11	2,09	2,05	2,08	16,42 %
Financial Services	1,55	1,57	1,53	1,52	5,83 %
Technical & Scientific services	1,55	1,51	1,46	1,48	23,26 %
Other services	1,31	1,28	1,27	1,23	9,16 %
Public administration	1,27	1,28	1,51	1,48	39,80 %
Education	0,83	0,85	0,83	0,82	11,08 %
Healthcare	0,83	0,82	0,81	0,80	9,45 %
Personal & Creative	1,34	1,36	1,32	1,34	16,60 %
Totalt	27,03 %	27,08 %	27,78 %	27,74 %	11,24 %

Figure 1 point to strong inter-industry cross-fertilization within the triangle consisting of Oil & Gas, MHT and MLT manufacturing, and suggests that it extends into a larger complex of skill-related industries that also include the Scientific and Technical Services, ICTs and HT manufacturing sectors. Notably,

the Financial Services, Hotels, Restaurants & Catering, and Trade sectors in which the region is specialised emerge as skill-unrelated with other domains of the local economy.

Figure 10-1 Skill-relatedness revealed by local labour market mobility in Oslo & Akershus, 2002-2012. Line thickness expresses the ratio of observed local mobility over expected mobility, i.e. the degree of revealed skill relatedness. Node size signifies location quotients. Grey nodes are sectors included in the innovation analysis. Only linkages where observed/expected > 1.1 are depicted



10.2 Baseline innovation profile

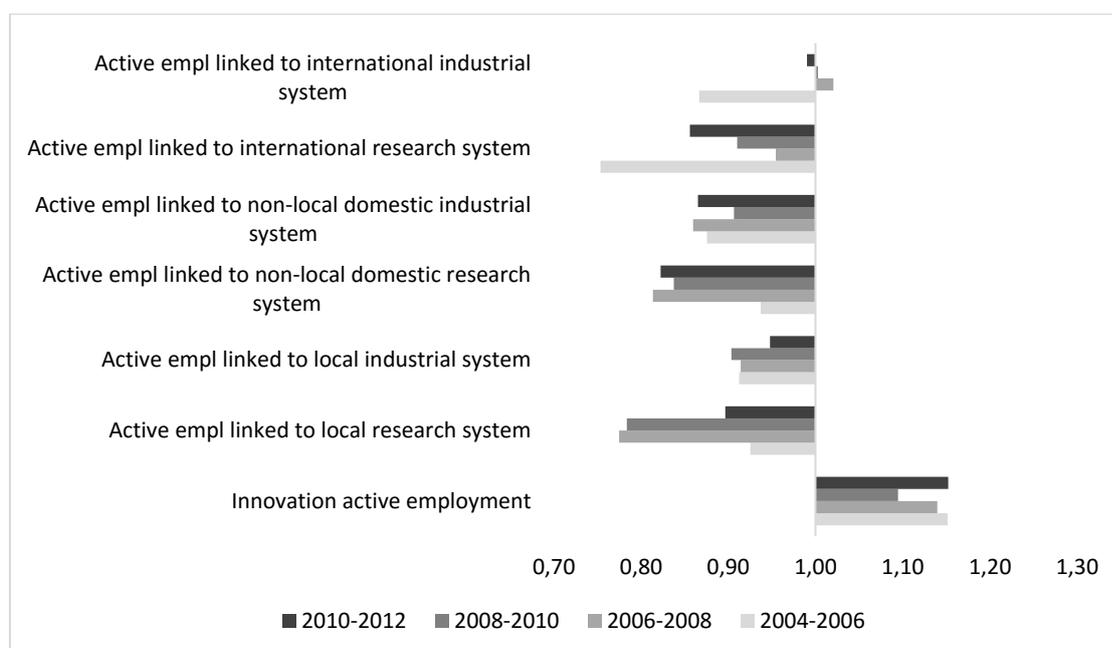
The first line in Table 10-2 below gives the number of establishments in the CIS sample. The second line gives the number of establishment that they represent, i.e. the population size estimated based on sampling weights provided by Statistics Norway.

Table 10-2 Number of establishment-level observations

	CIS2006	CIS2008	CIS2010	CIS2012
Unweighted (sample)	1964	2083	2080	2118
Weighted (population)	4875	4504	4296	4460

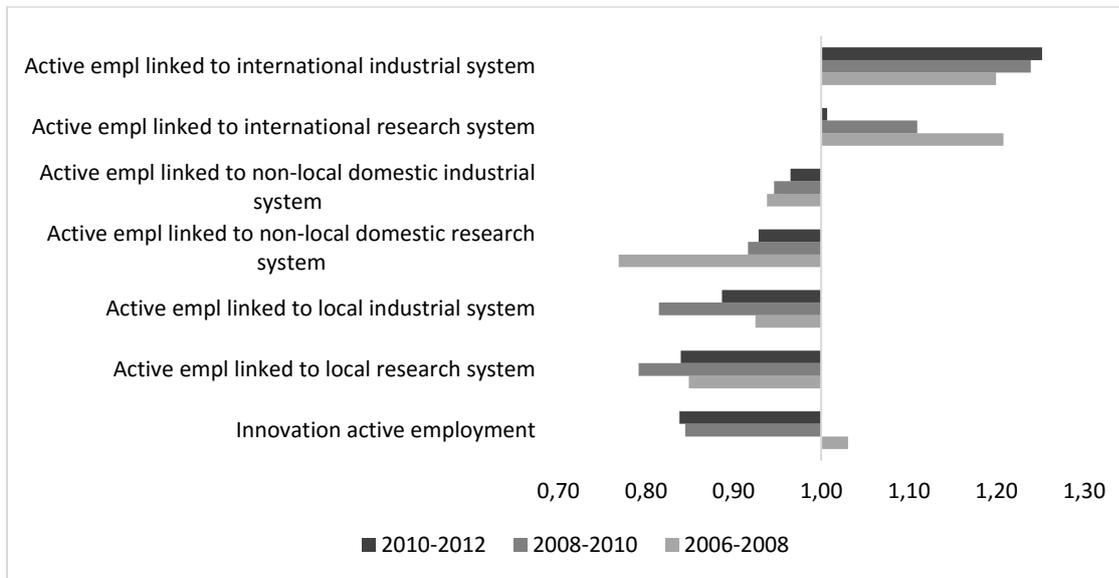
Being by far the largest of the 15 VRI regions, Oslo & Akershus weigh heavily in the national averages. Still, and consistent with recent research on urban knowledge dynamics in Norway (S. J. Herstad, 2017), innovation activity levels were above this average throughout the period considered (Figure 10-1). Innovation activity was particularly strong in 2006-2008 (Figure 10-2); yet, substantially lower in the two last waves of the CIS and in the two first (Figure 10-3). Thus, the downward trend is present also in the Capital.

Figure 10-2 Innovation profile Oslo & Akershus, relative to Norway = 1



Relative to Norway as a whole (Figure 10-1), the region underperforms in all types of collaboration considered. This is consistent with the idea of 'fragmented urban regions' put forward in previous research and suggest that policy attention dedicated to local networking is warranted (Tödttling & Trippel, 2005). Still, compared to the region itself at the beginning of the period, international industrial collaboration grew steadily. International research system collaboration, by contrast, peaked in 2006-2008 and then declined to the levels exhibited at the beginning of the period.

Figure 10-3 Innovation profile Oslo & Akershus, relative to region in 2006 = 1

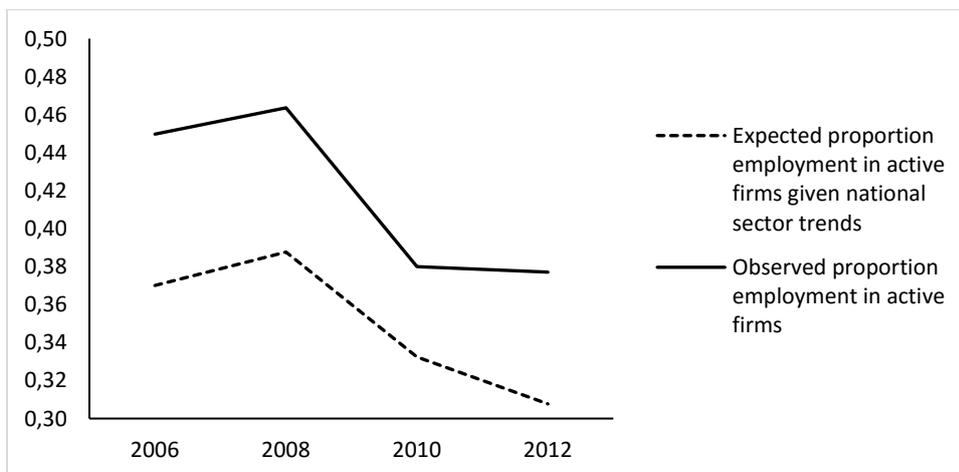


Local research system collaboration was particularly weak in 2008-2010, and remained in 2010-2012 at a level well below the national average and that observed in the region at the beginning of the period. This is notable, given the number, diversity and strength of local research institutions present in the Capital.

10.3 The micro-foundations for RIS

Figure 10-4 below shows that the levels of innovation activity observed in the Capital region have been well above those that would be expected given the composition of the regional economy and national sector-level trends. Notably, the gap between expected and observed innovation-active employment increased substantially in the last round of the CIS, as observed levels remained constant while expected levels decreased as a result of the downward domestic trend. Thus, relative to domestic trends, the micro-foundations for RIS construction were strengthened during the period.

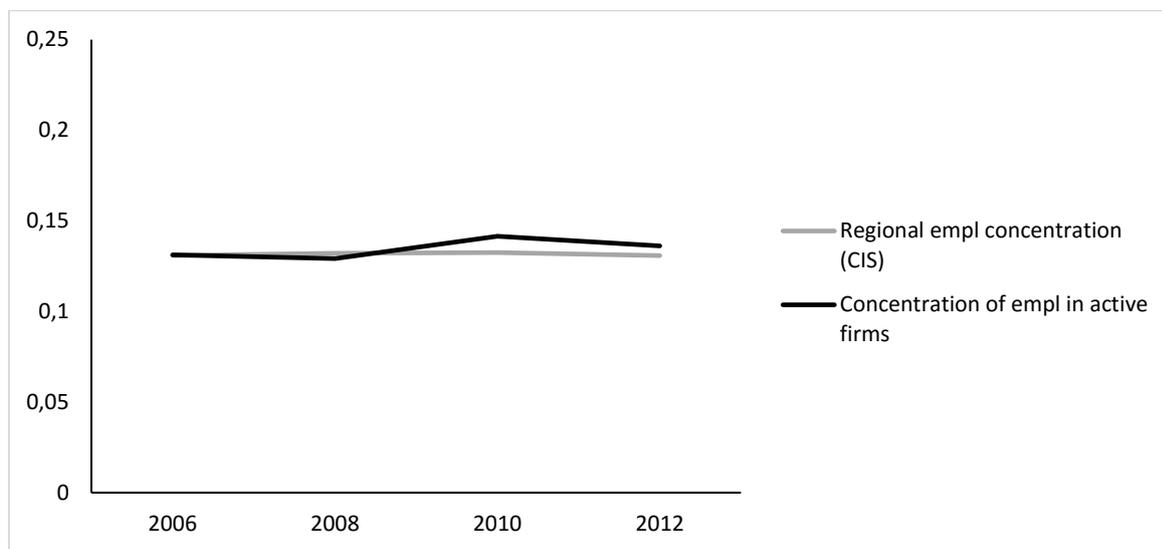
Figure 10-4 Observed vs. expected innovation activity in Oslo & Akershus



A large-city region characteristic is concentration scores for innovation active employment that are more or less equal to the concentration of scores of employment in general, meaning that innovation activity is relatively evenly distributed on the different, and diverse, industrial activities that comprises

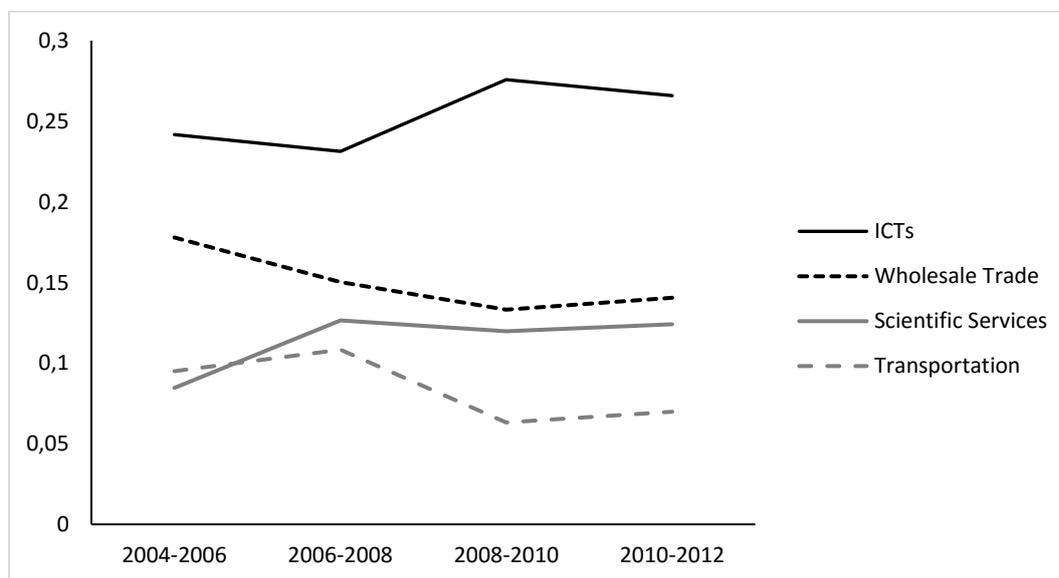
the regional economy. Consequently, the foundations for RIS construction are not only strong but also broad.

Figure 10-5 Concentration of innovation active employment in Oslo & Akershus



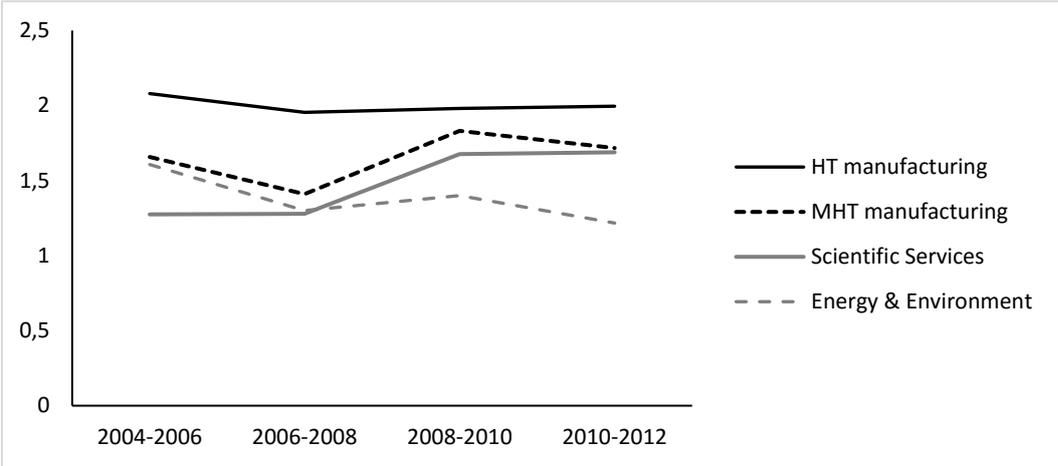
Reflecting the importance of innovation to competitiveness in the ICT sector and the tendency of this sector to concentrate in urban agglomerations, it accounted at the end of the period for an impressive 28 per cent of all innovation active employment in the Capital region. Moreover, the Technical & Scientific Services sector accounted in 2010-2012 for 12 per cent of active employment, up from 8 per cent at the beginning of the period. Wholesale trade and transportation are both large contributors of innovation-active employment, yet, reduced their relative contributions during the period.

Figure 10-6 Sector contribution o innovation-active employment in Oslo & Akershus. The three largest at the beginning and end of the period



Of the largest contributors it is only Technical & Scientific Services that is also among the most committed, exhibiting increasing levels. The commitment of the HT manufacturing sector remained more or less constant at high levels through the period, while the MHT manufacturing sector increased its commitment and the Energy & Environment sector reduced it slightly. Still, the picture is one of stability in who the largest contributors to innovation are, and who are the most committed.

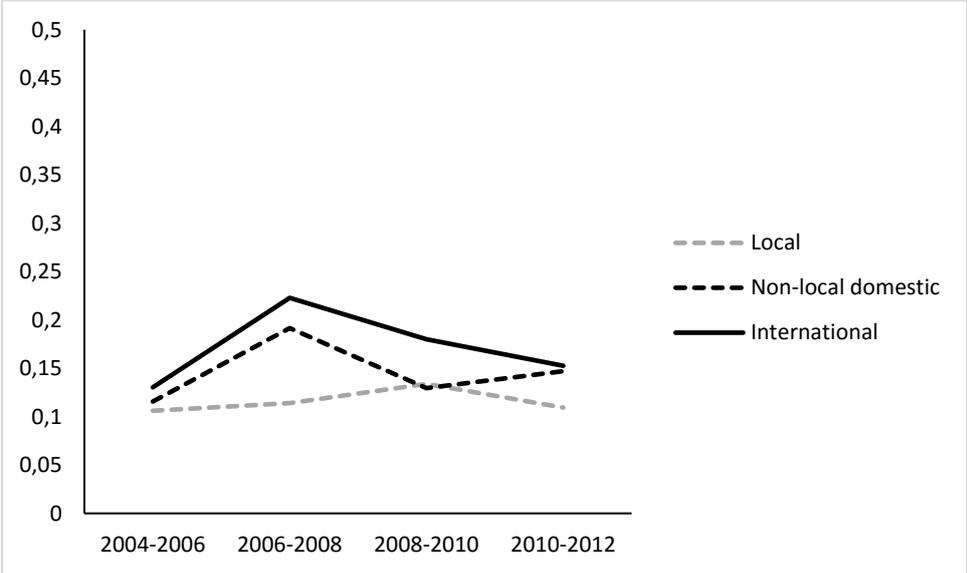
Figure 10-7 Sector commitment to innovation activity in Oslo & Akershus. *The three most committed at the beginning and end of the period*



10.4 The narrow definition of RIS: Local research system linkages

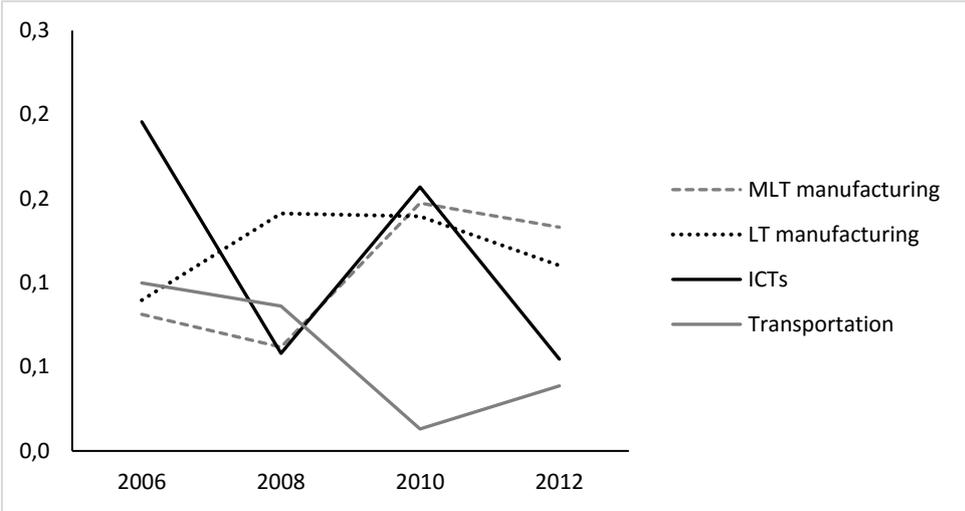
During the early years of the period, all types of research system linkages maintained by the industrial base of the Capital region became more concentrated. Still, following a decline during the later stages, concentration scores were at the end of the period comparable with those at the beginning. Reflecting the large size of the region, concentration levels are generally very low.

Figure 10-8 Sector concentration of research system collaboration in Oslo & Akershus



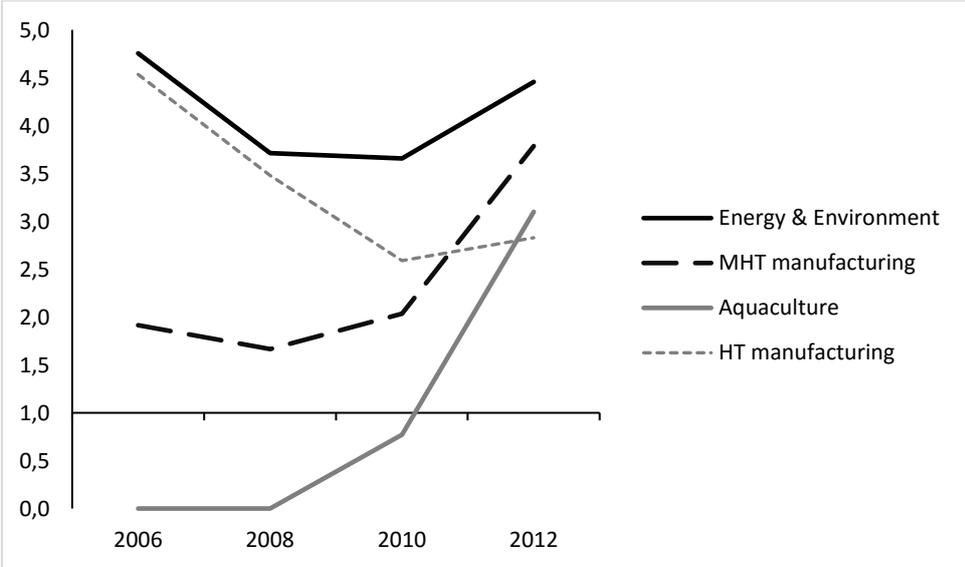
Given the size of the Capital region, the large number of observations on which the analysis is based, and the characteristics of local research system institutions pointed to above, it is striking to find relative large period-to-period fluctuations in the collaborative linkages of the largest contributing sectors. In particular, strong fluctuations around a downward trend for the ICT industry is notable given the size and contribution of this sector to regional innovation activity and the role of the Western Capital as the main ICT stronghold of Norway.

Figure 10-9 Sector contribution to local research system collaboration in Oslo & Akershus. The three largest at the beginning and end of the period



Commitment levels, by contrast, are less fluctuating and none of the largest contributors figure among those that are most committed. Moreover, the most committed sector at the end of the period have exhibited relatively stable (Infrastructure, Energy & Environment) or steadily increasing levels during the period. The latter applies in particular to the MHT manufacturing and Aquaculture sectors, which contribute between 3 and 4 per cent more than would be expected from their relatively small sizes. The HT manufacturing sector, which exhibited a stable overall commitment to development work during the period, substantially reduced its commitment to local research system collaboration. This and the low commitment of the large ICT sector (which excludes it from Figure 10-10) raises the question of whether local research system institutions during the period have foremost been able to mobilize firms directly engaged in booming natural resource-based activities (i.e. aquaculture) or strongly influenced by such booms (Oil & Gas sector technology providers operating in the MHT manufacturing sector)

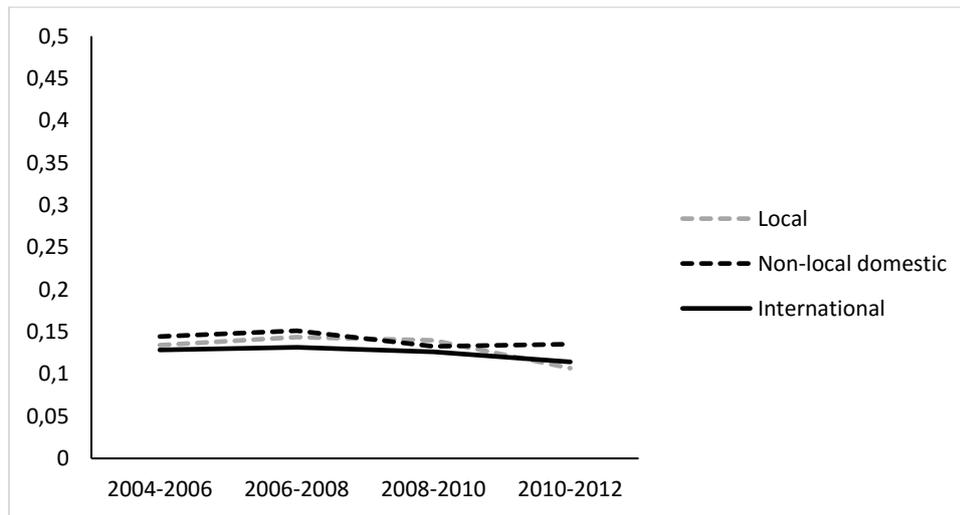
Figure 10-10 Sector commitment to local research system collaboration in Oslo & Akershus. The three most committed at the beginning and end of the period



10.5 The broad definition of RIS: Local inter-firm linkages

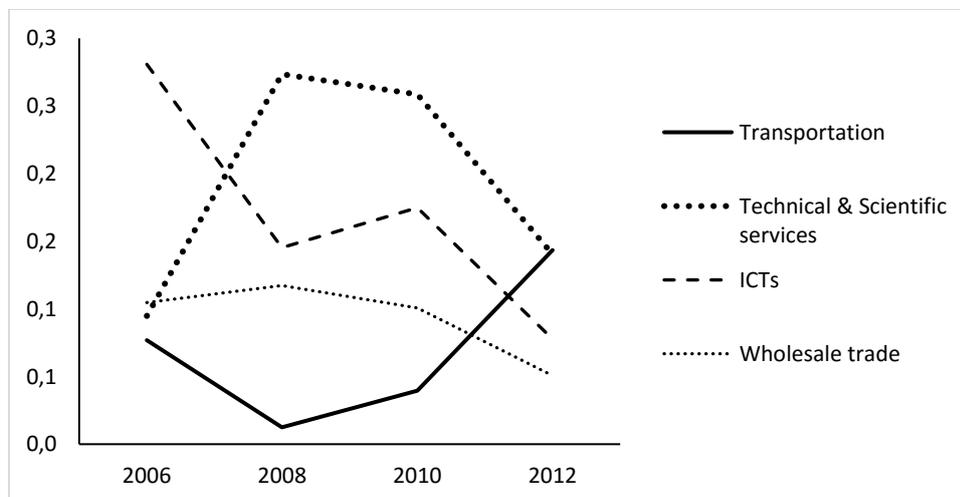
Figure 10-10 below portrays a unique picture of collaborative linkages that are neither more nor less specialised at certain spatial scales compared to others, and stable throughout the period considered. Moreover, and reflecting the size of the region, concentration levels are exceptionally low. Consistent with prior research on urban knowledge dynamics in the Norwegian Capital, this means that a broad range of industrial sectors is involved in industrial collaboration at all spatial scales (S. Herstad & Ebersberger, 2015; S. J. Herstad, 2017).

Figure 10-11 Sector concentration of industrial collaboration in Oslo & Akershus



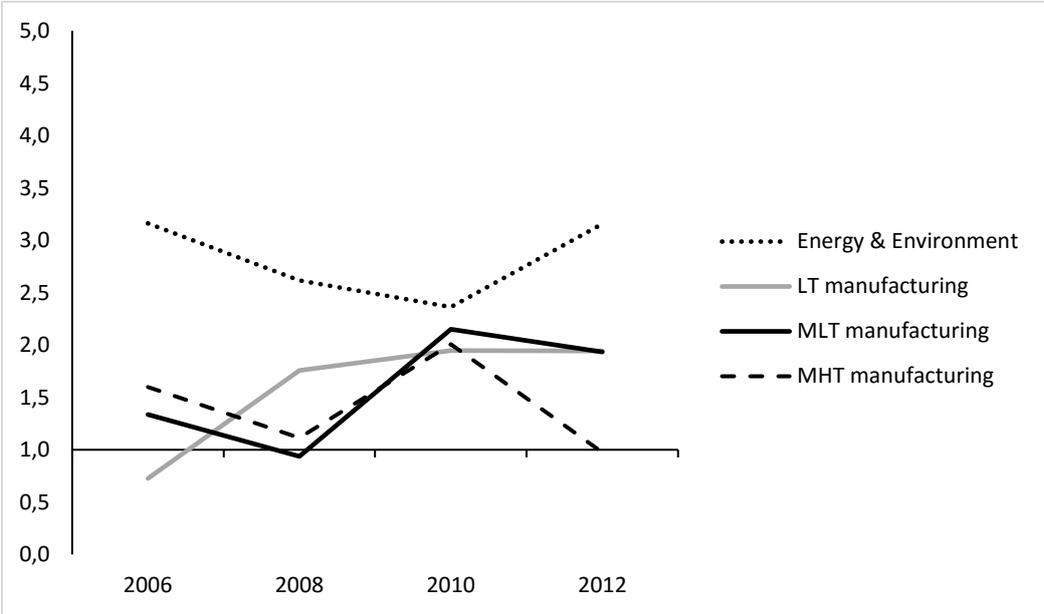
The local industrial networks of the Capital are dominated by industries that are typically agglomerated in urban regions, notably ICTs, Technical & Scientific Services and Wholesale trade. Moreover, the Transportation sectors (which include shipping and other advanced logistics services), is among the largest contributors. This is perhaps not surprising, because the provision of logistics services inherently involves interaction with other actors locally as well as domestically and abroad. Notably, the downward trend in local collaboration that was detected in the relationship between ICTs and local research system institutions is even more sharp and consistent for the involvement of the sector in local industrial collaboration.

Figure 10-12 Sector contribution to local industrial collaboration in Oslo & Akershus. The three largest at the beginning and end of the period



In spite of a decline during the yearly years of the period, the Infrastructure, Energy & Environment sector remained at the end of the period highly committed to local industrial collaboration. LT manufacturing and MLT manufacturing increasing their commitments during the period, while the commitment levels of MHT manufacturing fluctuated strongly. This stands in contrast to the stable increase in commitment to research system collaboration exhibited by this particular industry group.

Figure 10-13 Sector commitment to local industrial collaboration in Oslo & Akershus. *The three largest at the beginning and end of the period*



10.6 Summary

The VRI region of Oslo & Akershus contains a broad range of industrial and public sector activities, and employment in advanced services industries is particularly over-represented. During the period, employment in all manufacturing industries declined, while employment in Oil & Gas, Construction, Infrastructure and Technical & Scientific Services grew at particularly high rates. Patterns of labour market mobility during the period 2002-2012 suggests that Oil & Gas, manufacturing industries, Infrastructure and Technical Services comprises a local cluster of skill-related industries, while large sectors such as Trade, Financial Services and to some extent even ICTs emerge as detached from, or weakly linked to, other sectors in the local economy.

The region exhibit high and stable levels of innovation activity, and low and stable levels of collaboration at all spatial scales. This highly notable, given that the region hosts the largest university, in addition to university colleges, business schools and research institutes. The contribution and commitment of the large ICT sector to local industrial and research system collaboration was reduced substantially during the period, in spite of this sector remaining the largest single contributor of innovation-active employment, accounting for almost a third. Moreover, the large Technical & Scientific Services sector reduced its commitment to local industrial collaboration, and is not among the top contributors or most committed to local research system collaboration; while the HT manufacturing sector reduced its commitment especially to local research system collaboration. In parallel to this, strong increases in commitment to local research system collaboration was observed for the relatively small Aquaculture activity in the region.

Taken together, this suggests that very strong foundations for the construction of RIS based on variety have not resulted in the emergence of any type of RIS-configuration that is defined by the nature, geography and strength of collaborative ties.

11 Rogaland

11.1 Region overview

The VRI region of Rogaland is the main operational stronghold for the Offshore Oil & Gas sector. During the period considered, high energy prices translated into high activity in this sector and its manufacturing and services supplier industries, and formed the basis for exceptionally strong overall employment growth in the region. In the Oil & Gas sector itself, employment grew by 81 per cent, and the local Construction industry expanded by more than 30 per cent. Strong employment growth is observed also in Technical & Scientific Services, and in MHT manufacturing, but containing Oil & Gas supplier industries.

Table 11-1 Location quotients & growth rates, Rogaland. Sectors marked with grey are fully covered in the harmonized CIS sample

	Location quotients				Employment growth
	2006	2008	2010	2012	2006-2012
Primary	1,16	1,07	1,10	1,00	-23,28 %
Mining & Quarrying	1,92	1,76	1,90	1,90	29,15 %
Oil & Gas	7,61	7,16	6,60	6,40	81,16 %
HT manufacturing	0,46	0,51	0,63	0,75	59,49 %
MHT manufacturing	0,82	0,89	0,90	0,98	30,30 %
MLT manufacturing	1,78	1,75	1,51	1,50	-16,38 %
LT manufacturing	1,05	1,02	1,00	0,96	-13,51 %
Infrastructure	0,99	0,84	0,79	0,77	-4,16 %
Construction	0,95	0,98	0,98	0,99	32,70 %
Trade	0,89	0,89	0,89	0,88	7,44 %
Transportation	0,98	0,95	1,02	1,01	11,12 %
Horeca	1,00	1,02	1,03	0,98	13,11 %
ICTs	0,69	0,70	0,72	0,73	30,21 %
Financial Services	0,69	0,70	0,68	0,63	2,89 %
Technical & Scientific services	0,93	0,97	1,03	1,00	45,85 %
Other services	1,05	1,03	1,08	1,10	27,20 %
Public administration	0,73	0,67	0,61	0,60	3,02 %
Education	0,89	0,86	0,87	0,87	15,12 %
Healthcare	0,88	0,88	0,87	0,87	17,35 %
Personal & Creative	0,82	0,84	0,80	0,78	16,43 %
Total	8,86 %	9,20 %	9,34 %	9,50 %	16,26 %

Table 11-2 Number of establishment-level observations

	CIS2006	CIS2008	CIS2010	CIS2012
Unweighted (sample)	936	992	976	1033
Weighted (population)	1911	1950	1861	1840

Measured in terms of employment captured by the CIS, Rogaland is the second largest of the 15 VRI regions. Thus, it weighs heavily into the national averages. Relative to these averages (Figure 11-2) and the region itself at the beginning of the period (Figure 11-3), innovation activity and collaboration fluctuated. Local research system and industrial collaboration was particularly strong in 2006-2008, but declined during the subsequent periods to levels below those exhibited at the outset.

Figure 11-2 Innovation profile Rogaland, relative to Norway = 1

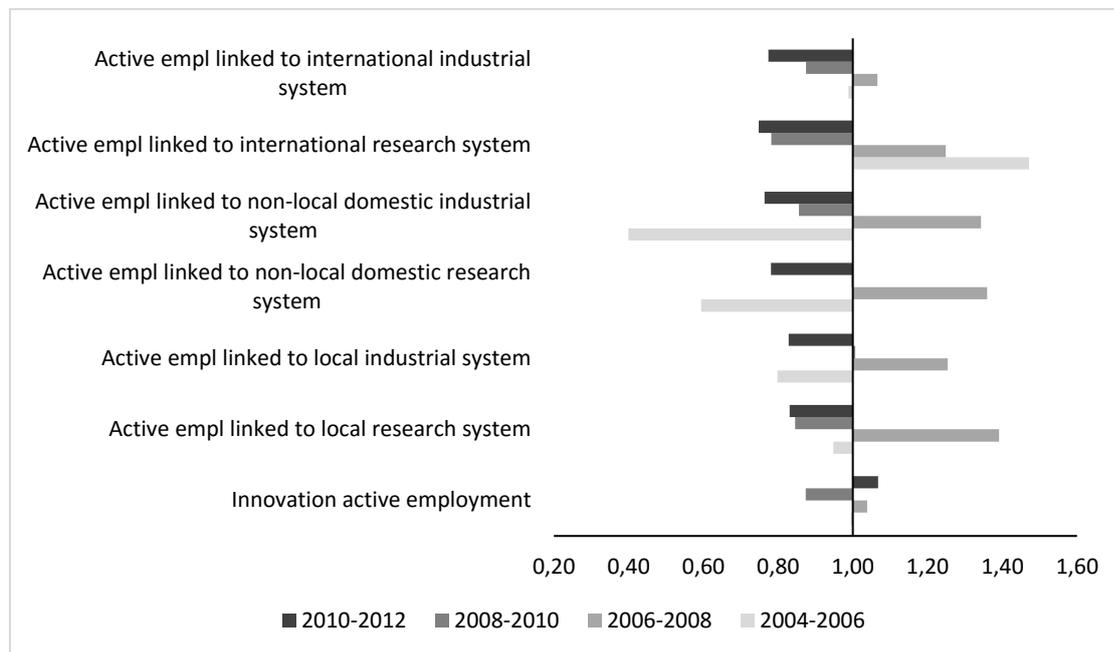
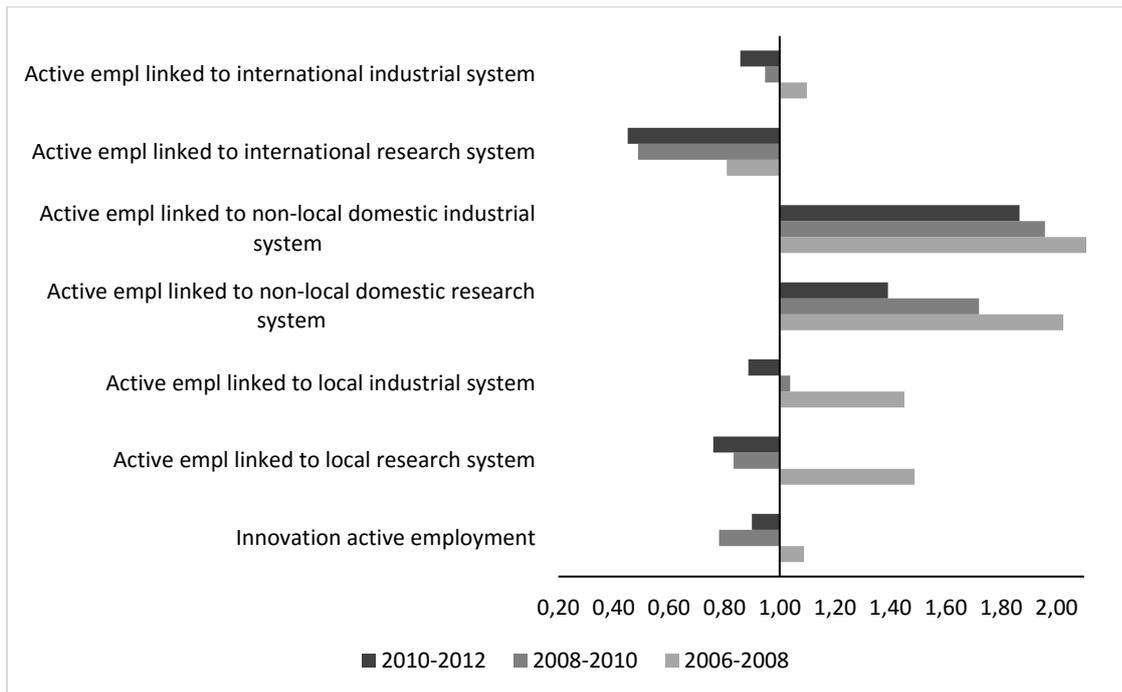


Figure 11-3 Innovation profile Rogaland, relative to region in 2006 = 1



11.3 The micro-foundations for RIS

Innovation activity in Rogaland has fluctuated around the levels that would be expected, given the composition of the regional industrial base and sector-level national trends. While it cannot be determined whether this indicates shift towards an upward regional trend, the sharp increase in innovation activity during the 2010-2012 period contradicts the national trend and is therefore notable.

Figure 11-4 Observed vs. expected innovation activity in Rogaland.

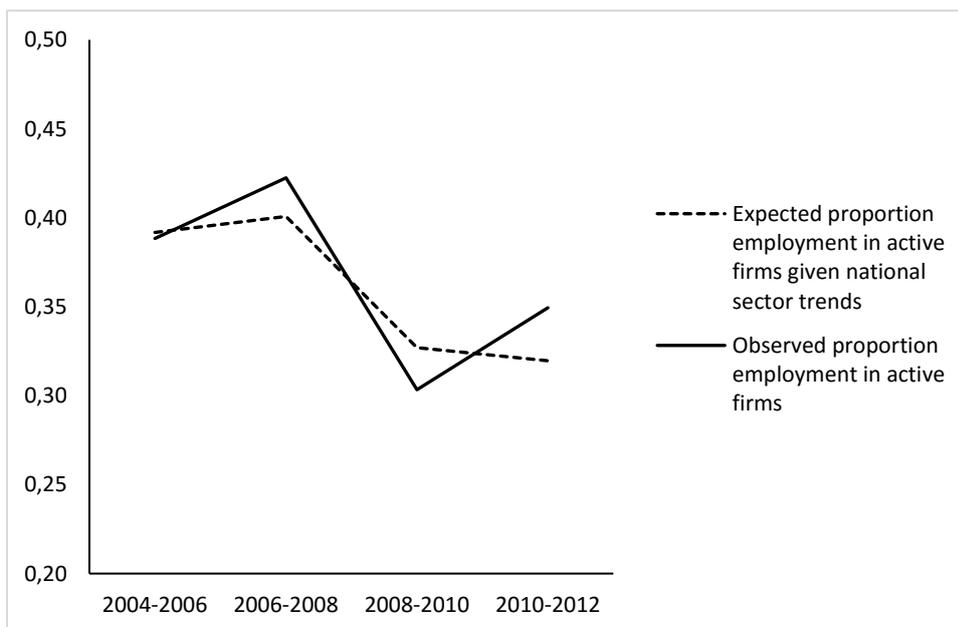


Figure 11-5 below shows that this increase in innovation activity was paralleled by an increase in the concentration of CIS employment, and an increase in the concentration of active employment towards levels well above those observed in other large-city regions. Thus, while employment in general and

active employment in particular became more evenly distributed on different industrial sectors during the early stages of the period, a lower number of sector accounted for larger proportions of employment and innovation activity during the later stages. This upward trend in overall CIS employment concentration is unique to Rogaland, and point to strong, underlying forces of industry specialisation driven by the Oil & Gas industry.

Figure 11-5 Concentration of innovation active employment in Rogaland

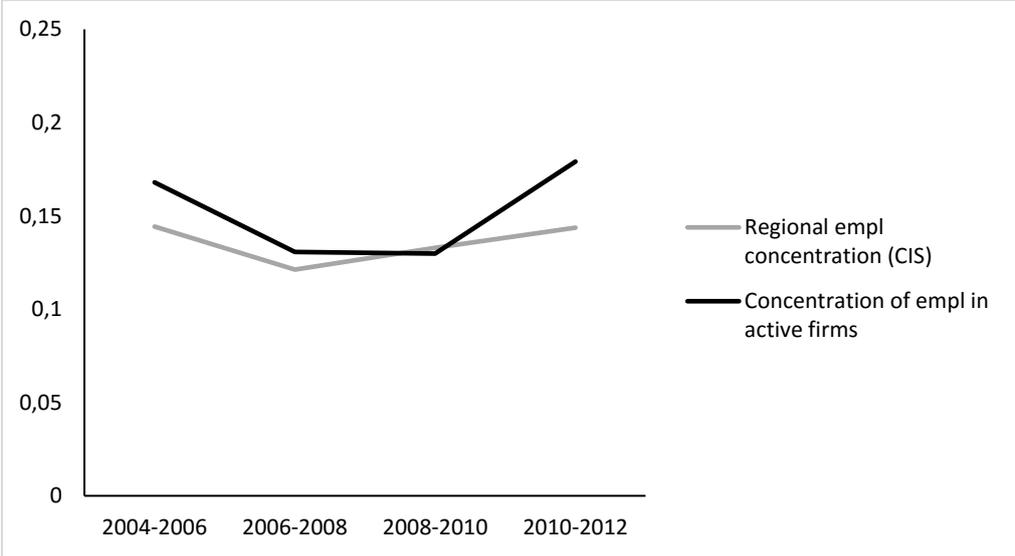
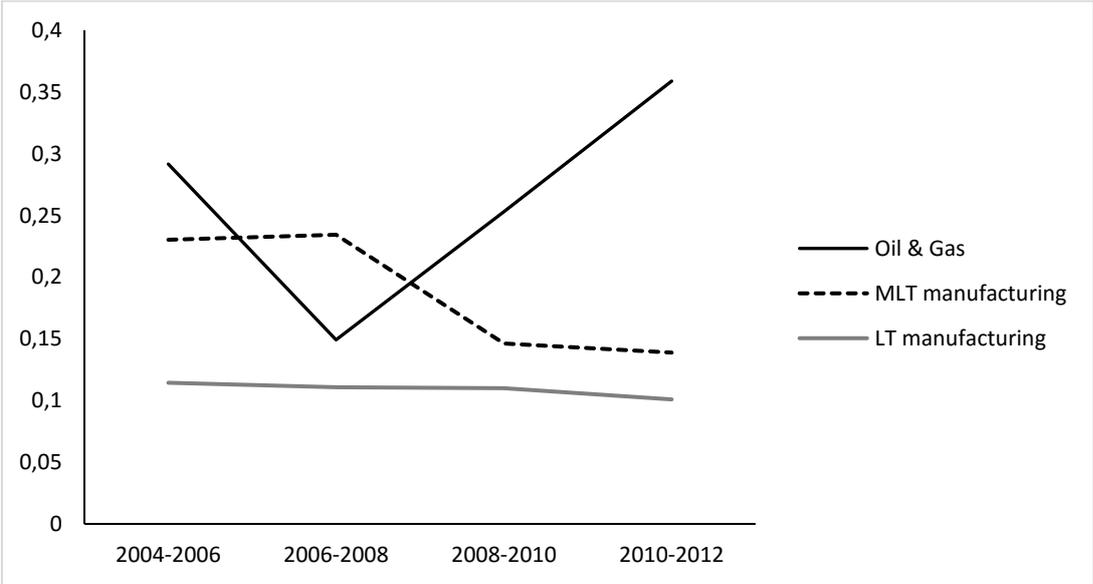


Figure 11-5 demonstrates that increasing concentration of active employment is associated with a dramatic increase in the contribution from the Oil & Gas sector during the later stages of the period. At the end of the period, this sector accounted for 36 per cent of innovation-active employment in Rogaland, up from only 15 per cent in 2006-2008. This increase is paralleled by a relative decrease in the contribution from the MLT manufacturing sector. The relative contribution from the LT manufacturing sector remained stable.

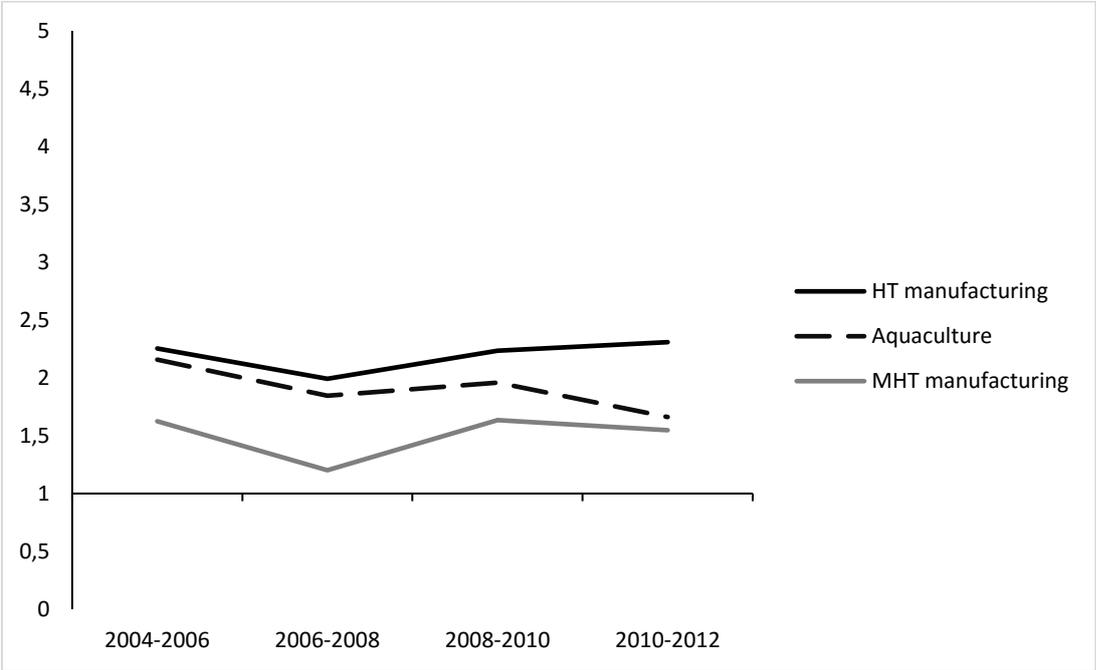
Figure 11-6 Sector contribution to innovation-active employment in Rogaland. The three largest at the beginning and end of the period



HT and MHT manufacturing, and aquaculture, are the sectors that are most committed to innovation in Rogaland. Including technology providers to the offshore Oil & Gas industry, the two former increased

their commitment slightly during the period, while the commitment of the latter fell somewhat (Figure 11-6). Still, the Aquaculture sector contributed in 2010-2012 66 per cent more innovation-active employment to the region than would be expected from its overall size.

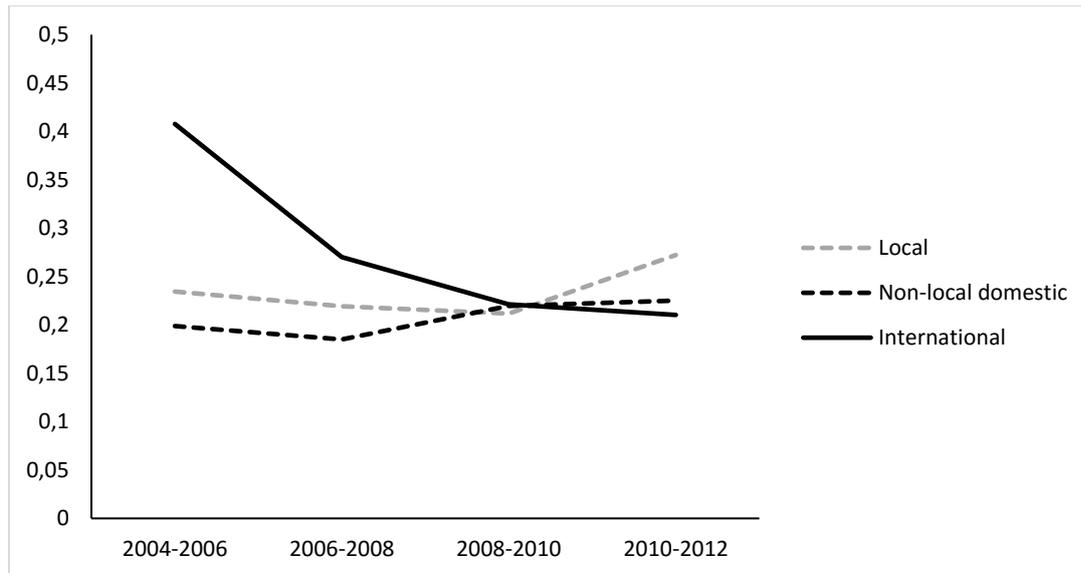
Figure 11-7 Sector commitment to innovation activity in Rogaland. *The three most committed at the beginning and end of the period*



11.4 The narrow definition of RIS: Local research system linkages

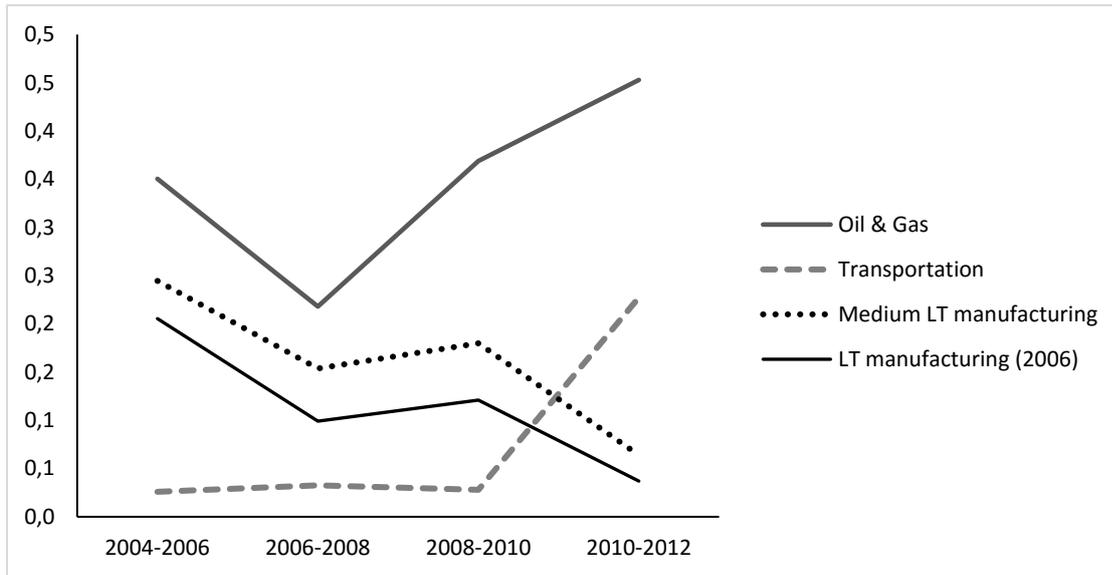
In terms of concentration, the research system linkages of Rogaland exhibited a remarkable development trend. On the one hand, Figure 11-8 demonstrates that international linkages became less specialised during the period. On the other, the region also exhibited increases in the concentration of local linkages and non-local domestic linkages, making the former more concentrated than the latter and international ones. This is a distinct region characteristic; higher concentration at higher geographical level is more commonly observed as international linkages are often driven by a limited range of international champions.

Figure 11-8 Sector concentration of research system linkages in Rogaland



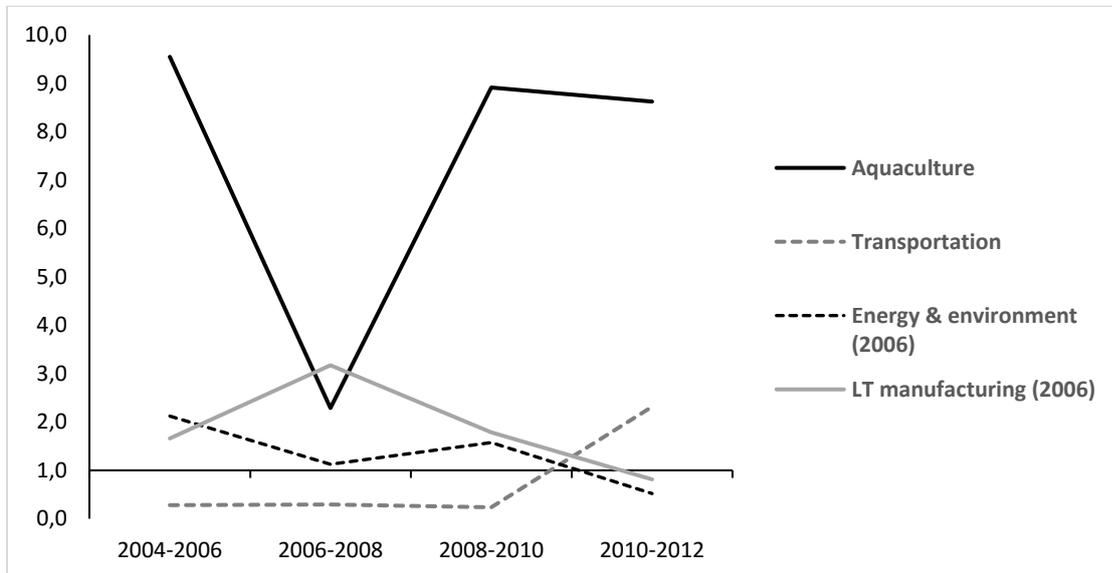
Local concentration increased during the later stages of the period, i.e. in tandem with the sharp increase in the contribution of the Oil & Gas sector to innovation activity. As can be seen from Figure 11-9, the overall growth in the contribution of this sector to innovation activity was paralleled by an exceptional growth in the contribution of this industry to local research system collaboration. The Transportation sector that contain operators of offshore vessels (and other ship-owners) also increased its contribution substantially, while the relative contribution from the MLT and LT manufacturing sectors declined sharply.

Figure 11-9 Sector contribution to local research system collaboration in Rogaland. The three largest at the beginning and end of the period



At the beginning of the period, the LT manufacturing and Infrastructure, Energy & Environment sectors contributed 1.67 and 2.1 times more to research system collaboration than would be expected from the size of these sectors (Figure 11-10). In 2010-2012, they contributed less. With the exception of 2006-2008, the Aquaculture sector remained throughout the period the single most committed to local research system collaboration. The commitment of the Transportation sector remained stable and low from 2004-2010, before the sector became strongly committed to local research system collaboration in 2010-2012.

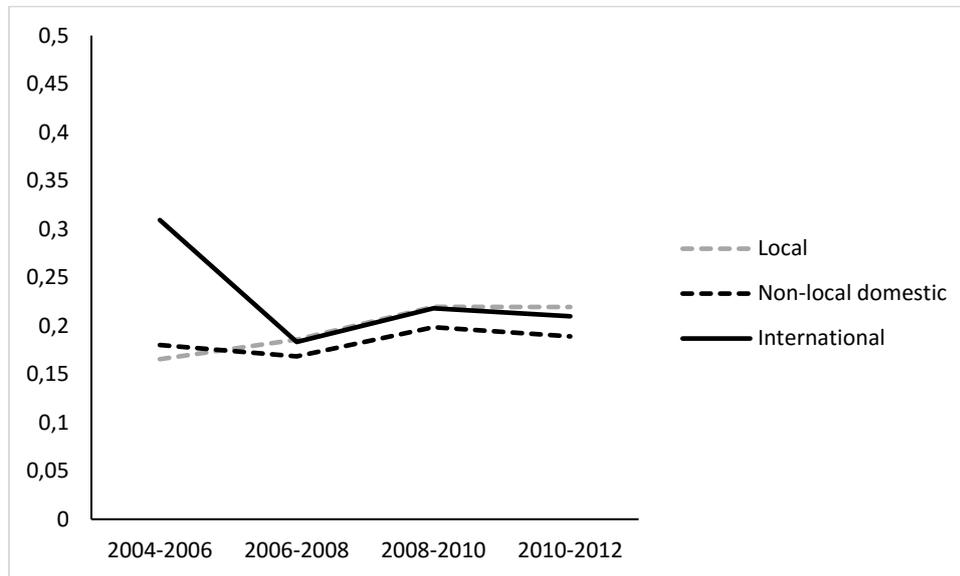
Figure 11-10 Sector commitment to local research system collaboration in Rogaland. The three most committed at the beginning and end of the period



11.5 The broad definition of RIS: Local inter-firm linkages

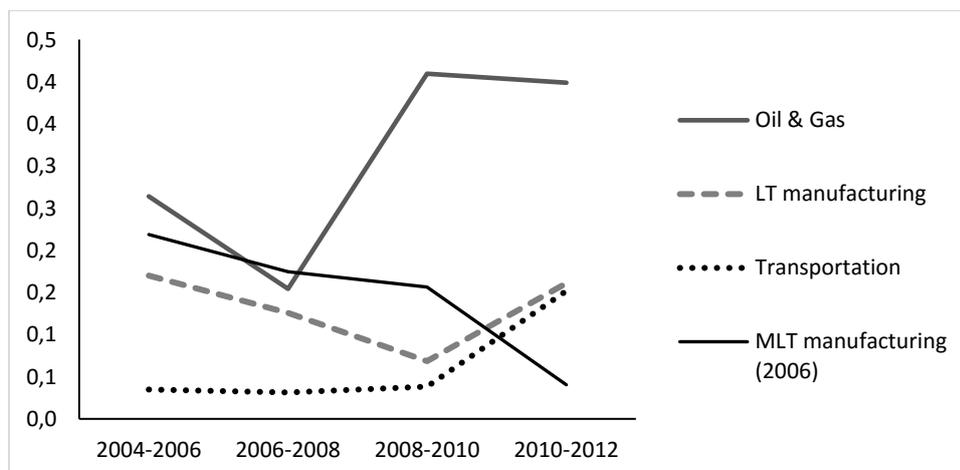
During the period, the concentration of international industrial linkages decreased as such linkages generally weakened, while the concentration of local and non-local domestic linkages increased in response to the growth in contribution from the Oil & Gas sector.

Figure 11-11 Sector concentration of industrial collaboration in Rogaland



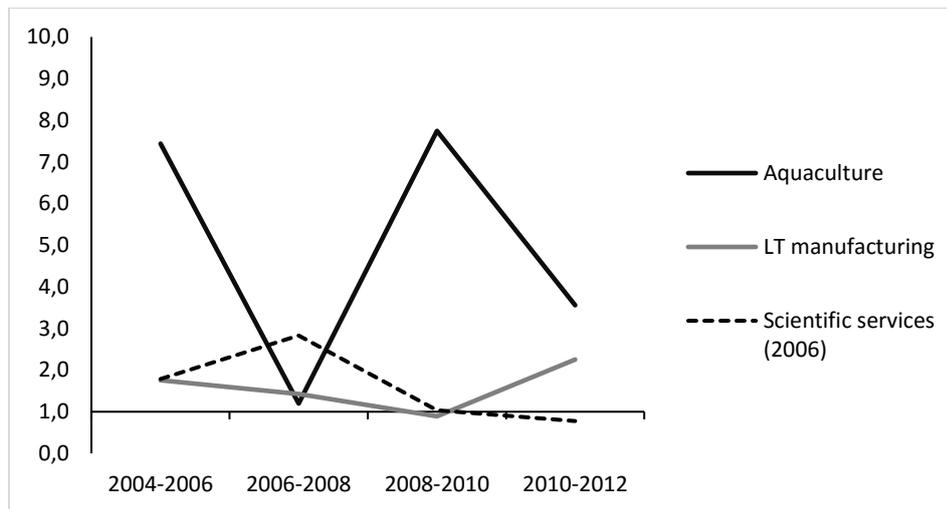
While the relative contribution of the Oil & Gas sector to local industrial collaboration grew, the proportion accounted for by the MLT manufacturing sector declined steadily and the sector was at the end of the period no longer among the top three contributors. The relative contribution from the LT manufacturing sector decreased steadily during the three first waves of the CIS, but increased at the end of the period to the 15 per cent level that established it as the second largest contributor. Notably, the sharp increase in the contribution and commitment of the Transportation sector (that include ship-owners and operators) to local research system collaboration was paralleled by a sharp increase also in its contribution to local industrial collaboration.

Figure 11-12 Sector contribution to local industrial collaboration in Rogaland. The three largest at the beginning and end of the period



As was the case for research system collaboration, the Aquaculture sector exhibit high yet also highly volatile commitment levels. The commitment of Technical & Scientific Services to local industrial collaboration, by contrast, declined steadily after 2006-2008, and the sector contributed at the end of the period less to such collaboration than would be expected from its size. Keeping in mind that the sector does not figure among the most committed to local research system collaboration, this is clearly at odds with the idea that the sector is positioned at the intersection between different innovation networks.

Figure 11-13 Sector commitment to local industrial collaboration in Rogaland. The three largest at the beginning and end of the period



11.6 Summary

The VRI region of Rogaland constitutes the main operational stronghold for the Norwegian Oil & Gas industry, a sectors which due to strong growth and associated one-way mobility inflows emerge as only weakly contributing to inter-sectorial cross-fertilization through regional labour market mobility. Consequently, one challenge for the region is to ensure that ideas, information and knowledge generated within the Oil & Gas sector spill over into the broader economy and benefit activities beyond those directly associated with Oil & Gas extraction. This points to the importance of active intervention through RIS construction.

Innovation activity levels in Rogaland have fluctuated around the national average, and the level exhibited by the region itself at the beginning of the period. At the end of the period, they were slightly above what would be expected given the industrial composition of the region and national sector-level trends. Thus, there are no clear-cut general trends with respect to the micro-foundations for RIS construction. Still, the relative contribution from the Oil & Gas sector to innovation-active employment increased strongly from the middle to the end of the period, and is mirrored in a decline in the relative contribution of the MLT manufacturing sector. Fluctuations are also observed in local research system and industrial collaboration. Not surprisingly, Oil & Gas is the single largest contributor to both types of collaboration, yet, does not rank among the most committed that are Aquaculture and the Transportation sector (local research system collaboration) and Aquaculture and LT manufacturing (local industrial collaboration).

Relatively high levels of concentration in local collaborative linkages and relatively low levels of concentration in international linkages points towards a polarized regional economy where the limited number of sectors that account for a large proportion of active employment benefit from local interaction, while a broader range of industrial activities that are smaller in size and fall outside the strong regional specialisation search internationally for relevant research system and industrial collaboration partners.

Linkages to non-local domestic research system institutions and non-local industrial networks were particularly strong during the 2006-2008 period, which marked the beginning of a downward trend. Taken together, this combined with fluctuating local collaboration dominated by the Oil & Gas sector and weak two-way labour market linkages between this sector and the surrounding economy suggests development away from the regionalized national innovation system characteristics exhibited at the outset, towards a specialised Oil & Gas cluster within a larger VRI region that is comprised also of non-Oil & Gas industrial activity provided with limited labour market and collaboration network support.

12 Sogn & Fjordane

12.1 Region overview

Accounting for only 2 per cent of Norwegian employment, Sogn & Fjordane is a small VRI region with over-representation of employment in primary industries, mining & quarrying, transportation and manufacturing industries with medium or low technology intensity.

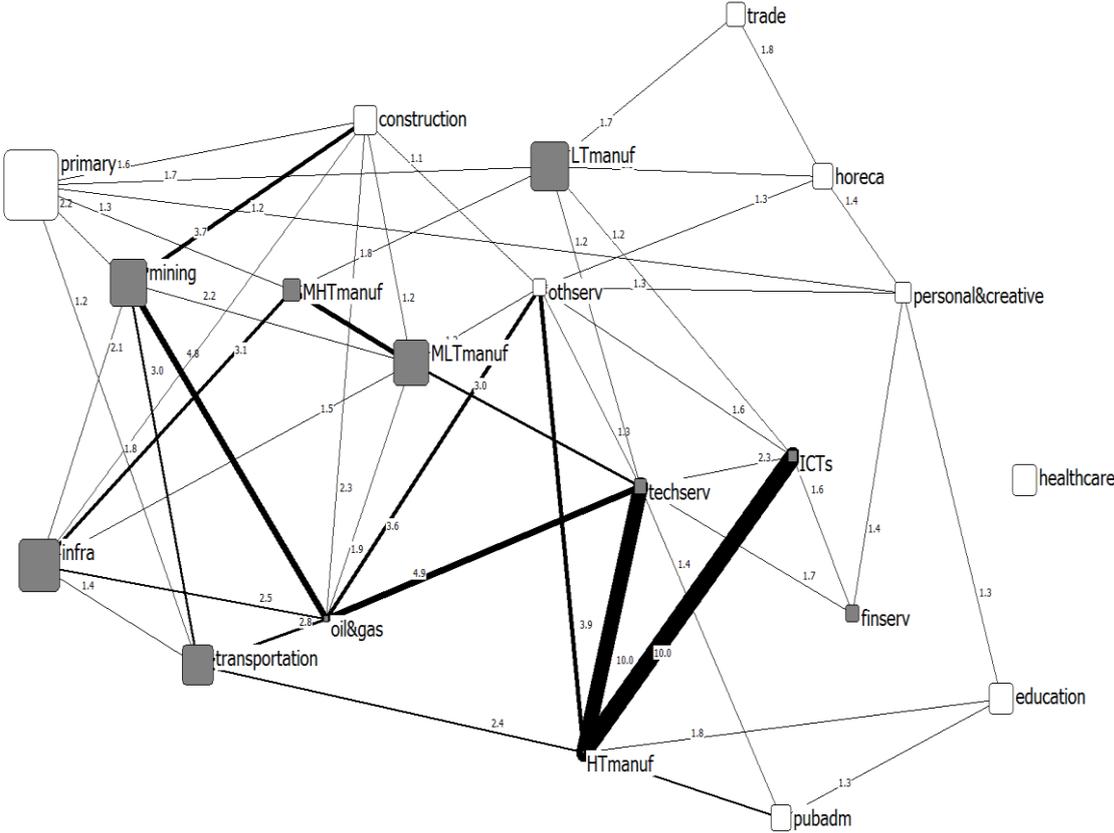
Table 12-1 Location quotients & growth rates, Sogn & Fjordane. Sectors marked with grey are fully covered in the harmonized CIS sample

	Location quotients				Employment growth
	2006	2008	2010	2012	2006-2012
Primary	2,55	2,59	2,71	2,56	-19,46 %
Mining & Quarrying	1,69	2,01	1,72	1,70	19,44 %
Oil & Gas	0,14	0,16	0,15	0,18	155,74 %
HT manufacturing	0,00	0,00	0,03	0,05	(1000 %)
MHT manufacturing	1,03	1,12	0,86	0,75	-27,59 %
MLT manufacturing	1,54	1,54	1,72	1,65	-3,61 %
LT manufacturing	1,53	1,61	1,72	1,78	-0,27 %
Infrastructure	1,76	1,84	1,85	1,89	20,50 %
Construction	1,01	1,01	1,00	1,01	14,26 %
Trade	0,80	0,82	0,80	0,81	1,32 %
Transportation	1,00	1,13	1,17	1,44	39,49 %
Horeca	0,95	0,92	0,93	0,88	-4,33 %
ICTs	0,39	0,38	0,41	0,37	6,04 %
Financial Services	0,67	0,63	0,63	0,58	-11,19 %
Technical & Scientific services	0,62	0,59	0,57	0,53	3,63 %
Other services	0,57	0,53	0,59	0,60	15,75 %
Public administration	0,81	0,86	0,89	0,88	23,70 %
Education	1,09	1,07	1,08	1,10	7,20 %
Healthcare	1,09	1,10	1,08	1,09	8,04 %
Personal & Creative	0,78	0,71	0,74	0,69	-2,24 %
Totalt	2,19 %	2,14 %	2,16 %	2,13 %	5,42 %

The industries in which the region is specialised exhibit moderate levels of skill-relatedness with each other. The relatively large Mining & Quarrying industry is skill-related with the small Oil & Gas sector; which also emerge as strongly linked by the labour market to Technical & Scientific Services. Inter-

industry knowledge transfers through mobility are particularly intense within a triangle consisting of the above-mentioned Technical & Scientific Services, ICTs and HT manufacturing. However, these are all industries in which the regional employment base is weak.

Figure 12-1 Skill-relatedness revealed by local labour market mobility in Sogn & Fjordane, 2002-2012. Line thickness expresses the ratio of observed local mobility over expected mobility, i.e. the degree of revealed skill relatedness. Node size signifies location quotients. Grey nodes are sectors included in the innovation analysis. Only linkages where observed/expected > 1.1 are depicted



12.2 Baseline innovation profile

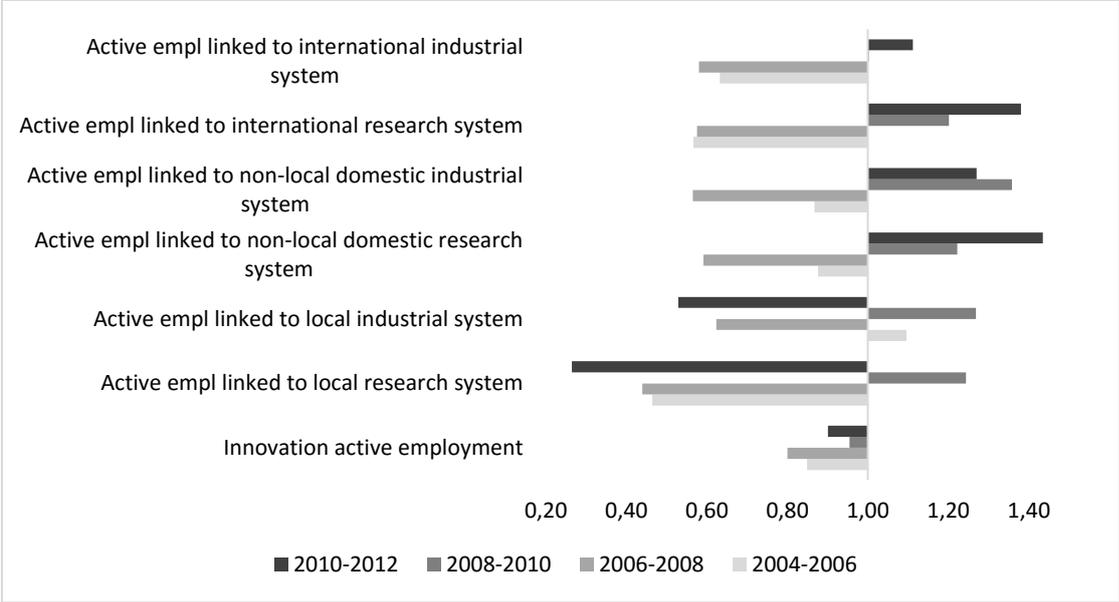
The first line in Table 12-2 below gives the number of establishments in Sogn & Fjordane that belong to enterprises sampled by the CIS. The second line gives the number of establishment that those that are sampled are meant to represent, i.e. the population size estimated based on sampling weights provided by Statistics Norway. Sogn & Fjordane is a small VRI region. As a result, detailed statistics on the contribution and commitment of different sectors to local collaboration cannot be reported, because. Furthermore, low N means that reported statistics must be interpreted with caution.

Table 12-2 Number of establishment-level observations

	CIS2006	CIS2008	CIS2010	CIS2012
Unweighted (sample)	239	245	254	237
Weighted (population)	497	437	482	453

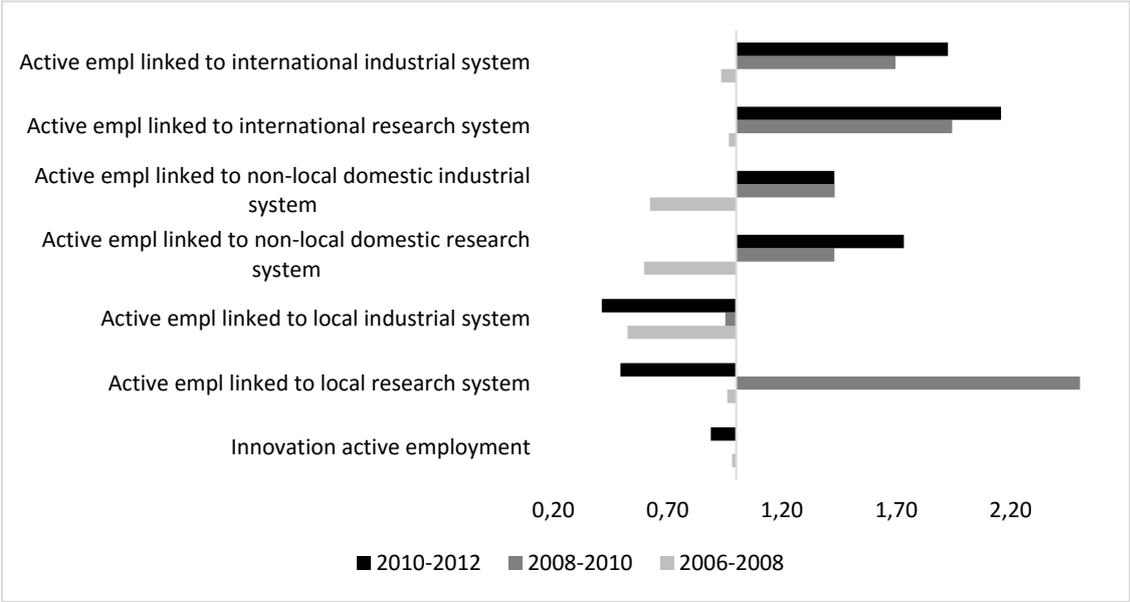
Compared to the national averages, the region exhibit fluctuating innovation activity and collaboration propensities, particularly at the local level. During the two later stages of the period, these is indications of strengthened collaboration outside the VRI region itself.

Figure 12-2 Innovation profile Sogn & Fjordane, relative to Norway = 1



Compared to the 2004-2006 regional baseline, the proportion of active employment engaged in non-local and international research system collaboration increased by a factor of 1.73 and 2.16 respectively. Local research system collaboration exhibited a peak in 2008-2010, and then declined sharply to levels below those exhibited in the two periods that cover the years 2004-2008. At the same time, the proportion of total employment occurring in firms with innovation activity remained stable at levels below the national average and comparable to those exhibited by the region itself in 2004-2006.

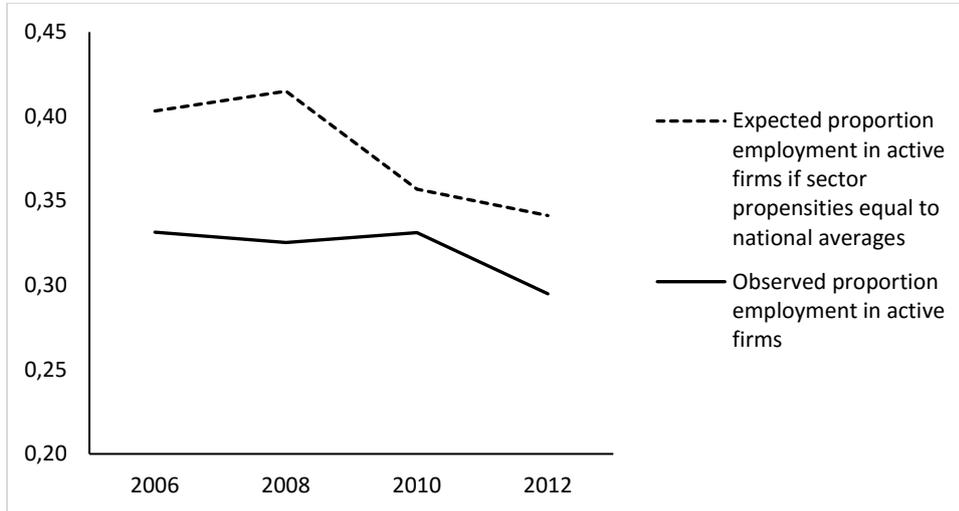
Figure 12-3 Innovation profile Sogn & Fjordane, relative to region in 2006 = 1



12.3 The micro-foundations for RIS

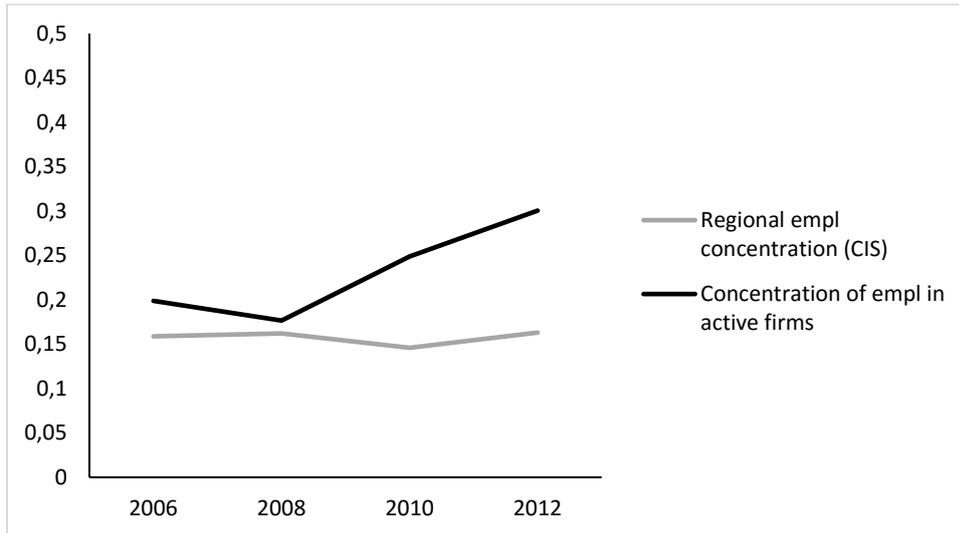
Figure 12-3 demonstrates that innovation activity in Sogn & Fjordane was below the expected level during the whole period considered, yet, decreased less than would be expected given the composition of the regional economy and domestic sector-level trends. Thus, relatively speaking, the foundation for RIS construction was strengthened somewhat.

Figure 12-4 Observed vs. expected innovation activity in Sogn & Fjordane



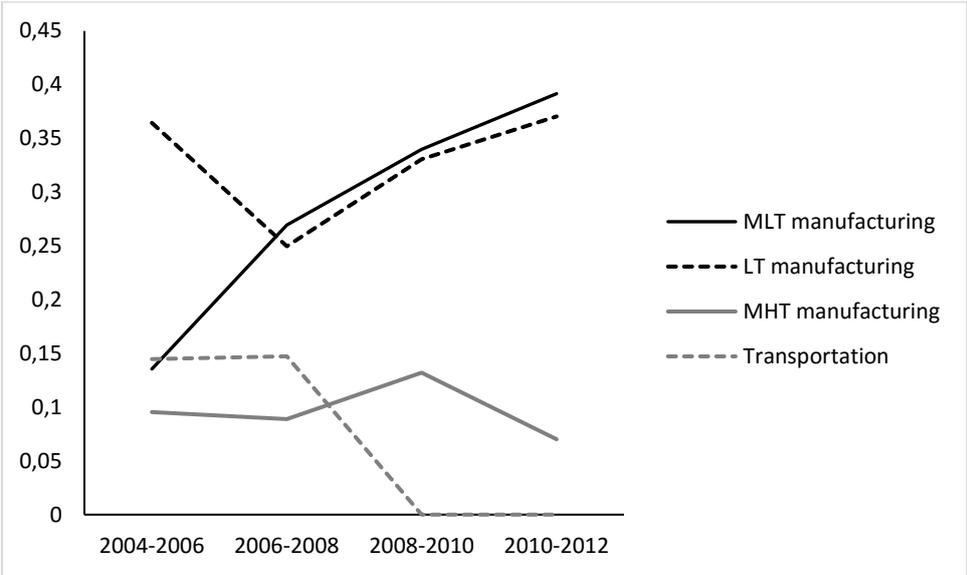
This coincided with a sharp increase in the sectorial concentration of innovation-active employment. Thus, a more limited number of industrial sectors accounted for a larger proportion of such employment at the end of the period, compared to at the beginning; in spite of employment concentration levels in the region as such remaining relatively stable.

Figure 12-5 Concentration of innovation active employment in Sogn & Fjordane



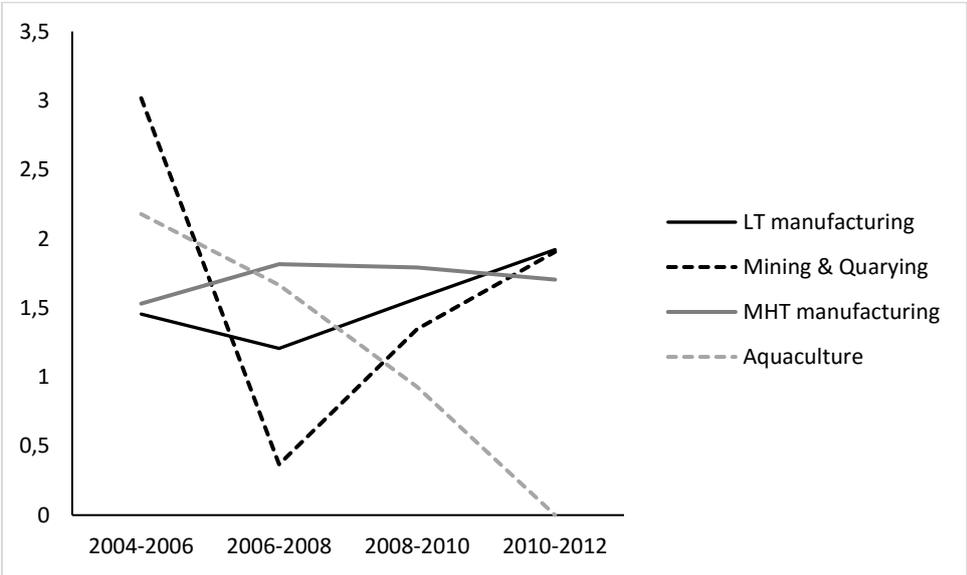
Consequently, stronger foundations do not equal broader foundations. As is revealed by Figure 12-6 below, the increase in levels and in concentration is associated with a strong increase in the contribution of the MLT manufacturing sector to innovation activity. It is paralleled by a drop in the relative contribution from the transportation sectors, which initially accounted for approximately 15 per cent of innovation activity, stable contributions from the MHT manufacturing sectors and strong contributions from the LT manufacturing sector.

Figure 12-6 Sector contribution to innovation active employment in Sogn & Fjordane



Notably, the MLT manufacturing sector is not among the most committed to innovation in Sogn & Fjordane. This means that the sector, in spite of its strong contribution to innovation, under-performs relative to its size. The contributions from the LT and MHT manufacturing sectors remained stable at high levels during the period, while the aquaculture sector that was the second most committed at the beginning reduced its commitment substantially; and consistently from period to period. Finally, a growth in the number of firms and employees that are engaged in mining & quarrying is paralleled by an increase in the commitment of this sector to regional innovation activity.

Figure 12-7 Sector commitment to innovation activity in Sogn & Fjordane. The three most committed at the beginning and end of the period



12.4 The narrow definition of RIS: Local research system linkages

Not surprisingly, increasing concentration of innovation-active employment is paralleled by sharp increases in the concentration of research system linkages. The level of concentration exhibited at the end of the period are exceptionally high, with concentration scores approaching 0.8 (international research system collaboration) and 0.6 (local research system collaboration). From Figure 12-7 below,

it is evident that the peak in local research system collaboration in 2008-2010 (cf. figure 12-2) was paralleled by exceptionally high levels of concentration. This means that strengthened specialisation of innovation activity and research system linkages is the most clear-cut trend in Sogn & Fjordane. The strengthened non-local domestic linkages exhibited by the region, by contrast, are more evenly distributed on different sectors.

Figure 12-8 Sector concentration of research system collaboration in Sogn & Fjordane

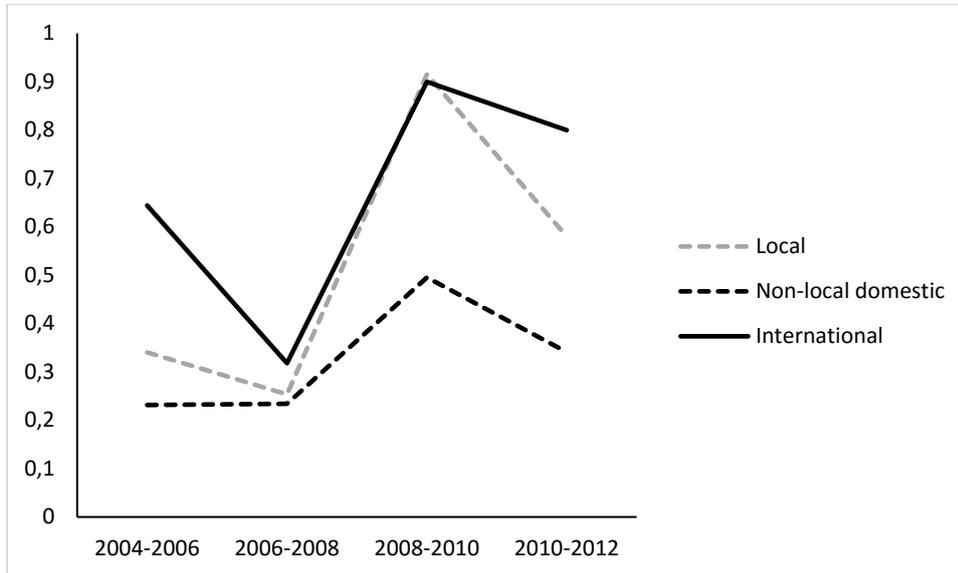


Figure 12-9 Sector contribution to local research system collaboration in Sogn & Fjordane. *This data cannot be reported due to data disclosure concerns.*

Figure 12-10 Sector commitment to local research system collaboration. *This data cannot be reported due to data disclosure concerns.*

12.5 The broad definition of RIS: Local inter-firm linkages

Strong industry concentration characterizes also the industrial networks of Sogn & Fjordane. Notably, the region exhibit comparable concentration scores for industrial networks at all geographical levels, and these have fluctuated in parallel during the period. This suggests that local industrial collaboration is intimately interlinked with collaboration at larger geographical scales, and adds to the evidence of development towards a regionalized national innovation system more so than a RIS.

Figure 12-11 Sector concentration of industrial employment in Sogn & Fjordane

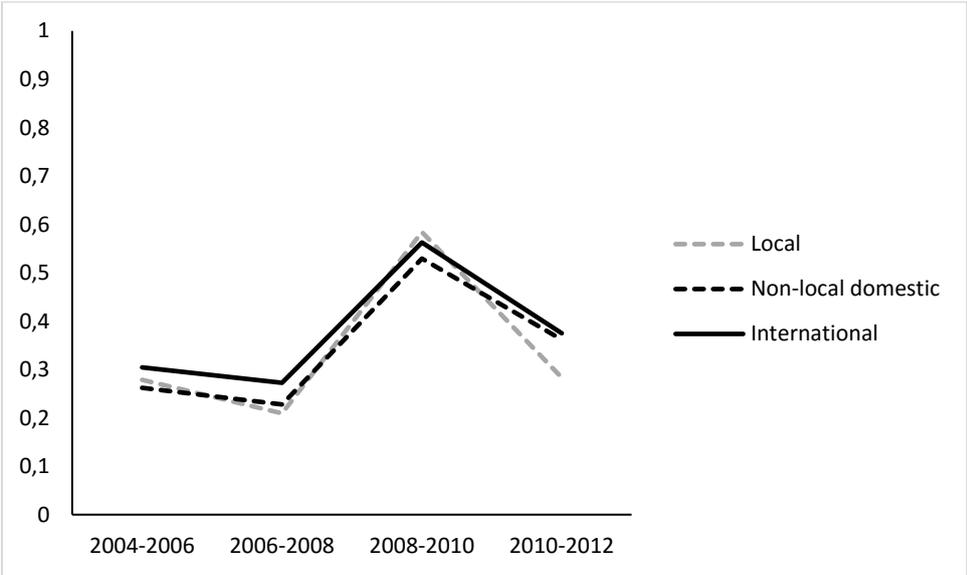


Figure 12-12 Sector contribution to local industrial collaboration in Sogn & Fjordane. *This data cannot be reported due to data disclosure concerns.*

Figure 12-13 Sector commitment to local industrial collaboration in Sogn & Fjordane. *This data cannot be reported due to data disclosure concerns.*

12.6 Summary

Innovation-active employment in Sogn & Fjordane is below what would be expected given the industrial composition of the region and national sector-level trends, yet, is relatively stable and increased somewhat at the end of the period. Innovation is dominated by the MLT and LT manufacturing industries. The latter is also the most committed to regional innovation, in addition to Mining & Quarrying and the small MHT manufacturing sector.

During the two later stages of the period, the region exhibited a more clear-cut trend of increasing commitment to non-local domestic collaboration, and to international collaboration. Local industrial collaboration was at the end of the period well below the levels exhibited at the beginning. Local research system collaboration fluctuated strongly around the national averages and the regional 2004-2006 reference, because it is strongly dominated by a limited number of industrial sectors comprised of a limited number of firms. Thus, detailed statistics cannot be reported.

Generally weak micro-foundations for RIS construction and fluctuating (research system) if not declining (industrial collaboration) local collaboration combined with stronger non-local domestic ties suggests that developed in Sogn & Fjordane is towards a regionalized national innovation system configuration, if not simply a cluster that within the larger VRI region encompasses a very limited number of firms and sectors.

13 Telemark

13.1 Region overview

Telemark is a small VRI region. It exhibited very weak overall employment growth during the period, and a substantial decline in employment in the MHT manufacturing industry weakened its domestic position in this industry. Strong growth rates were observed in Technical & Scientific Services, and in the Oil & Gas industry which was more or less absent in the region at the beginning of the period.

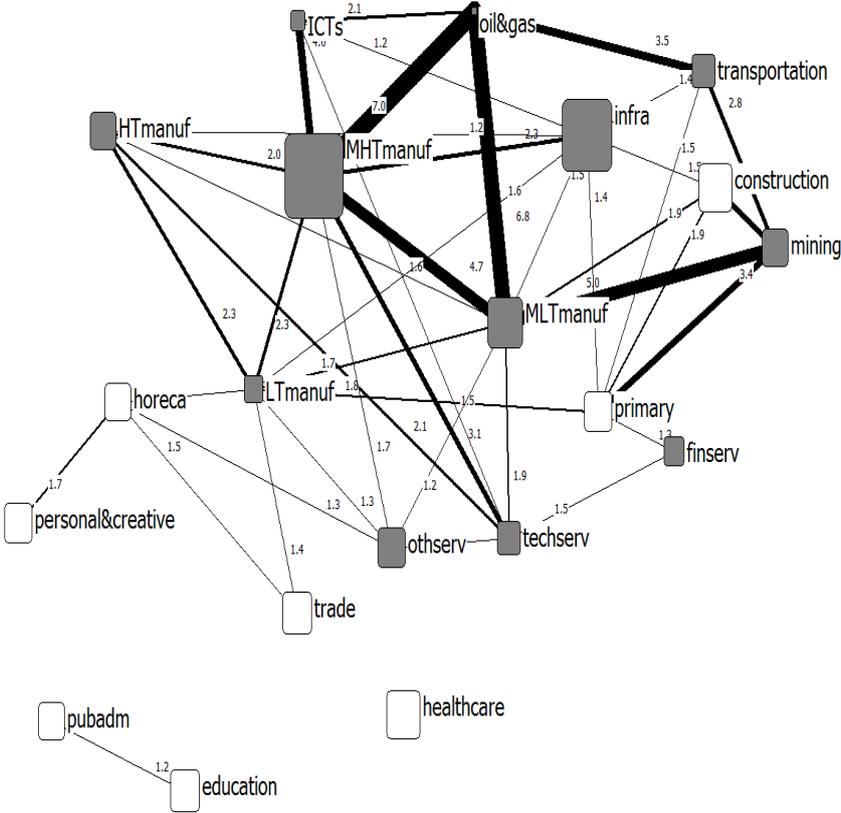
Table 13-1 Location quotients & growth rates, Telemark. Sectors marked with grey are fully covered in the harmonized CIS sample

	Location quotients				Employment growth
	2006	2008	2010	2012	2006-2012
Primary	0,88	0,88	0,80	0,94	-16,81 %
Mining & Quarrying	1,28	1,16	0,87	0,92	-17,83 %
Oil & Gas	0,00	0,04	0,12	0,08	(4950 %)
HT manufacturing	0,96	0,96	0,98	0,90	-19,31 %
MHT manufacturing	3,43	2,56	2,64	2,18	-39,23 %
MLT manufacturing	1,18	1,32	1,26	1,23	-9,21 %
LT manufacturing	0,63	0,58	0,58	0,61	-20,32 %
Infrastructure	1,76	1,84	1,88	1,85	14,20 %
Construction	1,19	1,17	1,18	1,20	11,27 %
Trade	0,94	0,97	0,98	1,02	3,77 %
Transportation	0,77	0,75	0,80	0,78	-5,31 %
Horeca	0,98	0,98	0,97	0,89	-9,06 %
ICTs	0,53	0,53	0,50	0,45	-7,74 %
Financial Services	0,63	0,65	0,63	0,64	0,57 %
Technical & Scientific services	0,75	0,75	0,80	0,79	24,09 %
Other services	1,01	1,03	0,96	0,93	-1,68 %
Public administration	0,86	0,89	0,87	0,87	9,67 %
Education	0,98	0,98	0,99	1,01	5,87 %
Healthcare	1,14	1,17	1,19	1,21	10,29 %
Personal & Creative	0,90	0,93	0,92	0,94	12,27 %
Totalt	3,15 %	3,11 %	3,01 %	2,96 %	1,62 %

From Figure 13-1 below, it is evident that emerging activities in the Oil & Gas industry are densely skill-related to the declining MHT manufacturing sector, and thus to a larger cluster of related

industries comprised also of MLT manufacturing and ICTs. Notably, the Technical & Scientific Services sector is related strongly to MHT manufacturing and HT manufacturing, yet only weakly skill-related with the ICT industry. Another notable feature is high revealed skill-relatedness between LT manufacturing, HT manufacturing and MHT manufacturing. This is contrary to the position of LT manufacturing in other Norwegian regions as relatively isolated from more technology-intensive industries and often related strongly to primary industries, mining or construction.

Figure 13-1 Skill-relatedness revealed by local labour market mobility in Telemark, 2002-2012. Line thickness expresses the ratio of observed local mobility over expected mobility, i.e. the degree of revealed skill relatedness. Node size signifies location quotients. Grey nodes are sectors included in the innovation analysis. Only linkages where observed/expected > 1.1 are depicted



13.2 Baseline innovation profile

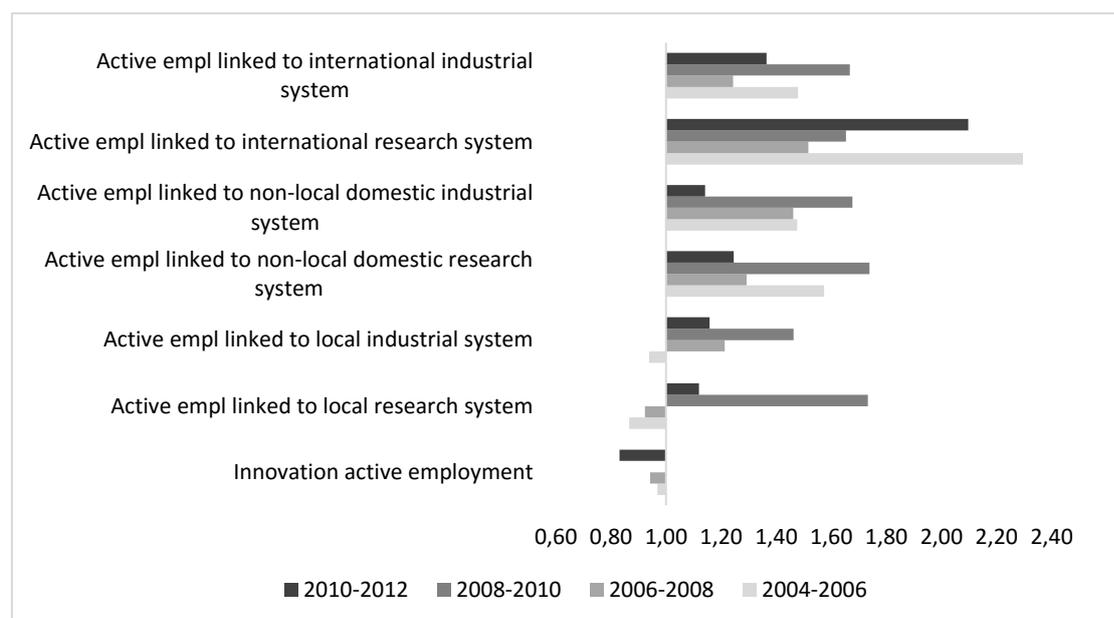
The first line in Table 13-2 below gives the number of establishments in Telemark that belong to enterprises sampled by the CIS. The second line gives the number of establishment that those sampled represent, i.e. the population size estimated based on sampling weights provided by Statistics Norway. Because Telemark is among the smaller VRI regions measured also in terms of CIS observations and employment, reported statistics must be interpreted with some caution.

Table 13-2 Number of establishment-level observations

	CIS2006	CIS2008	CIS2010	CIS2012
Unweighted (sample)	317	308	313	306
Weighted (population)	641	619	589	562

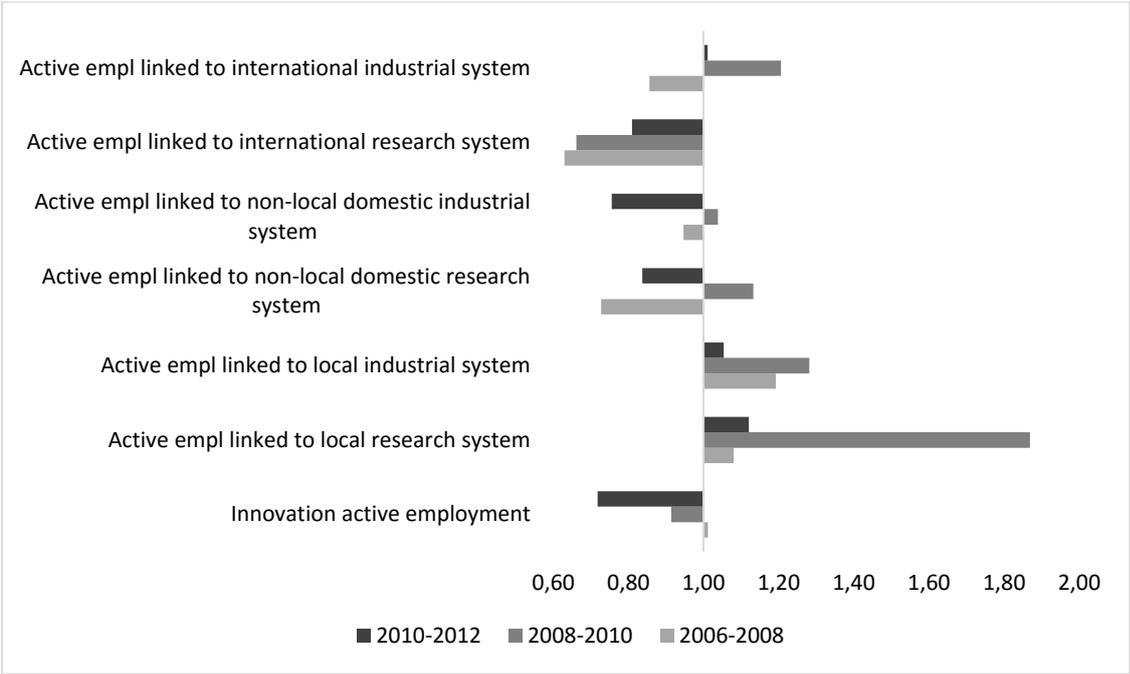
Innovation activity remained relatively stable compared to the declining national average (Figure 12-1). Still, levels were at the end of the period substantially below those exhibited in the region at the beginning of it. Non-local domestic and international linkages are strong compared to the national average. The region exhibited a drop in international research system collaboration from 2004-2006 to 2006-2010; but this recovered slightly at the end of the period and remained well above the national average.

Figure 13-2 Innovation profile Telemark, relative to Norway = 1



Local research system linkages were above the national averages throughout the period considered. They exhibited a peak in 2008-2010; but declined at the end of the period to a level of 12 per cent above that exhibited in 2004-2006. Local industrial collaboration show a similar pattern, as levels are consistently above the national average and increased slightly from 2004-2006 to 2010-2012. Instead of exhibiting a clear trend, non-local domestic research system collaboration and non-local domestic industrial collaboration fluctuated around levels above the national average yet comparable to those exhibited by the region itself in 2004-2006.

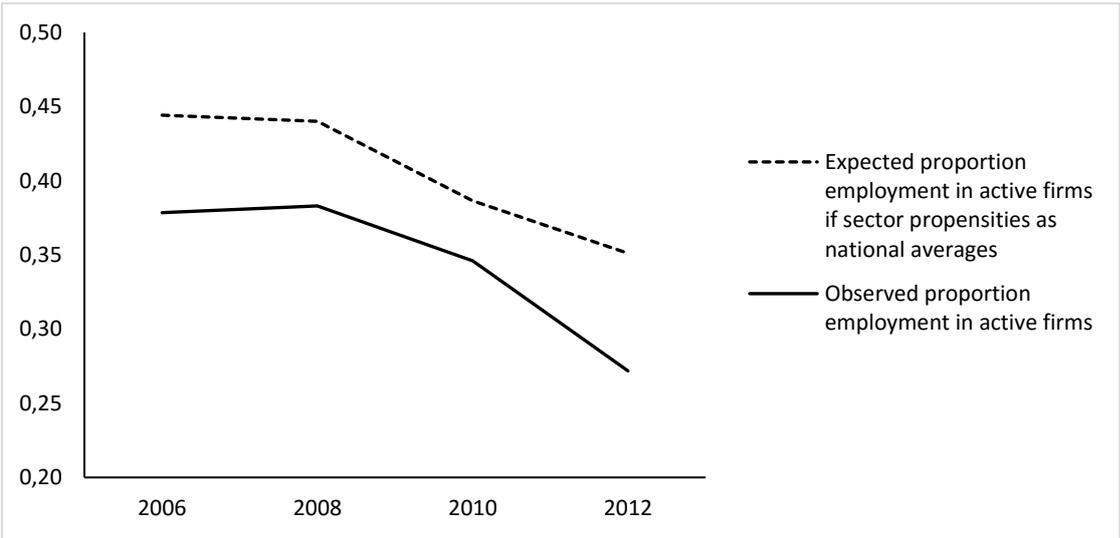
Figure 13-3 Innovation profile Telemark, relative to region in 2006 = 1



13.3 The micro-foundations for RIS

Throughout the period, observed innovation activity in Telemark was below the levels that would be expected, given the composition of the regional economy and national sector trends (Figure 13-4). The decrease in innovation active employment exhibited by the region at the end of the period (cf. Figure 13-2) increased the gap between expected and observed innovation activity. In this sense, the micro-foundations for RIS have been weakened.

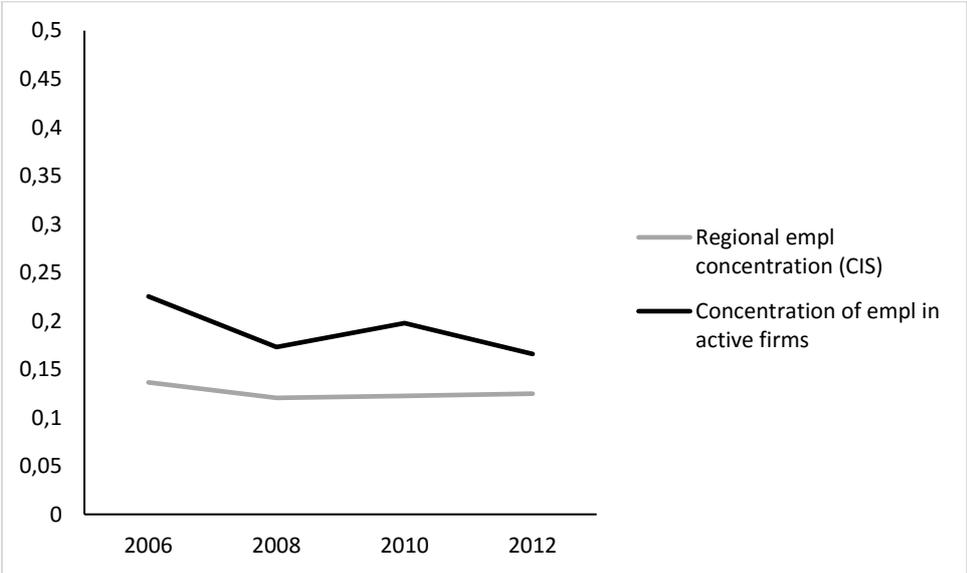
Figure 13-4 Observed vs. expected innovation activity in Telemark.



In parallel with this, Telemark exhibited a decrease in the concentration of innovation-active employment (Figure 13-5), from very high levels at the outset to levels approaching those of CIS employment as a whole. Concentration scores were when the contribution from the MHT manufacturing sector to innovation active employment peaked (Cf. Figure 13-5). This underscores the

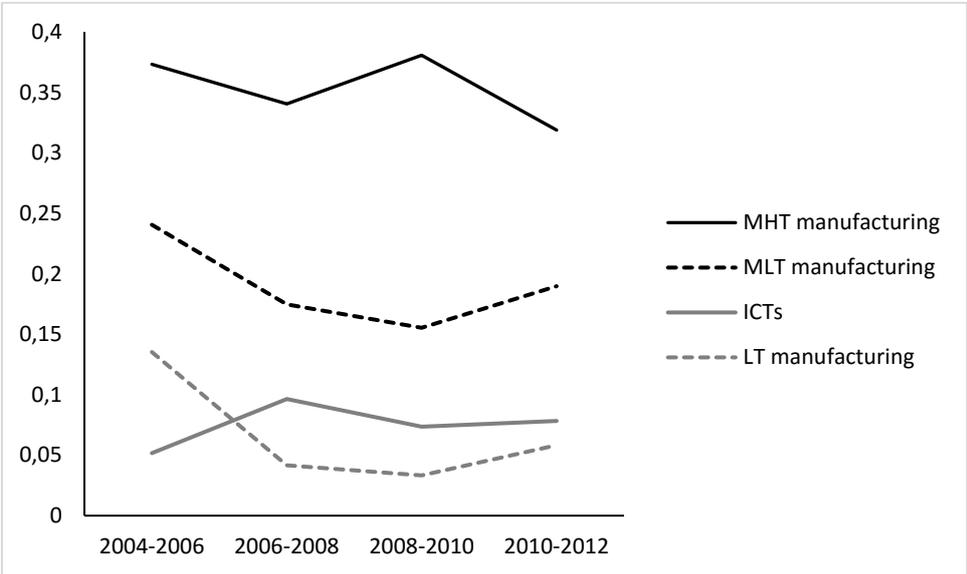
dependence of regional innovation activity on employment levels and strategic decisions in this specific sector.

Figure 13-5 Concentration of innovation active employment in Telemark



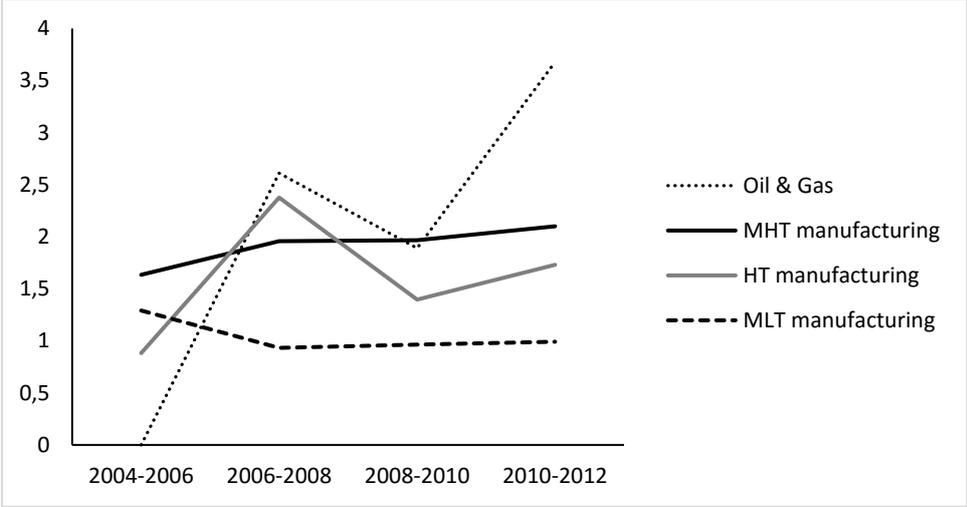
At the beginning of the period, the three manufacturing sectors were the largest contributors of innovation-active employment to Telemark. Through the period, an increase in the contribution from the ICT sector is paralleled by decreasing contributions from the MLT and LT manufacturing sectors.

Figure 13-6 Sector contribution to innovation-active employment in Telemark. The three largest at the beginning and end of the period



Still, the ICT sector does not rank among the three most committed to regional innovation. Instead, the period is characterized by stable commitment from the MHT and MLT manufacturing sectors, fluctuating commitment from the HT manufacturing sector and a dramatic increase in the commitment from the regions' small Oil & Gas sector. At the end of the period, this sector contributed 3.7 times more innovation-active employment than would be expected from its size. This suggests that sector activity in the region is motivated access to networks and competences in support of development work.

Figure 13-7 Sector commitment to innovation activity in Telemark. *The three most committed at the beginning and end of the period*



13.4 The narrow definition of RIS: Local research system linkages

Through the period considered, the concentration of non-local and international research system collaboration increased on a relatively stable basis. Local collaboration exhibited more fluctuating concentration scores, with a distinct peak in the period 2008-2010 when local collaboration as such also peaked (cf. Figure 13-1 and 13-2) and reached levels well above those for collaboration domestically and abroad.

Figure 13-8 Sector concentration of research system collaboration in Telemark

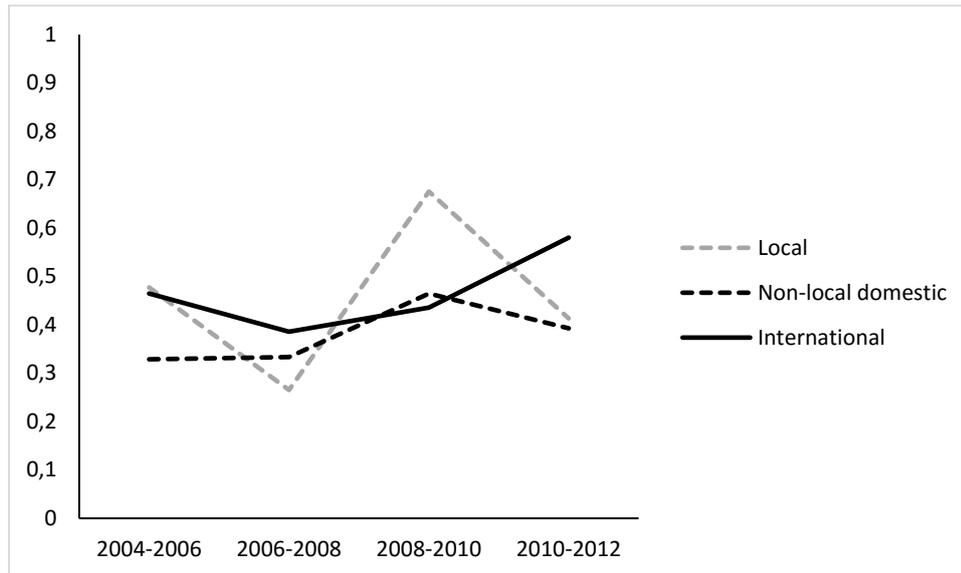
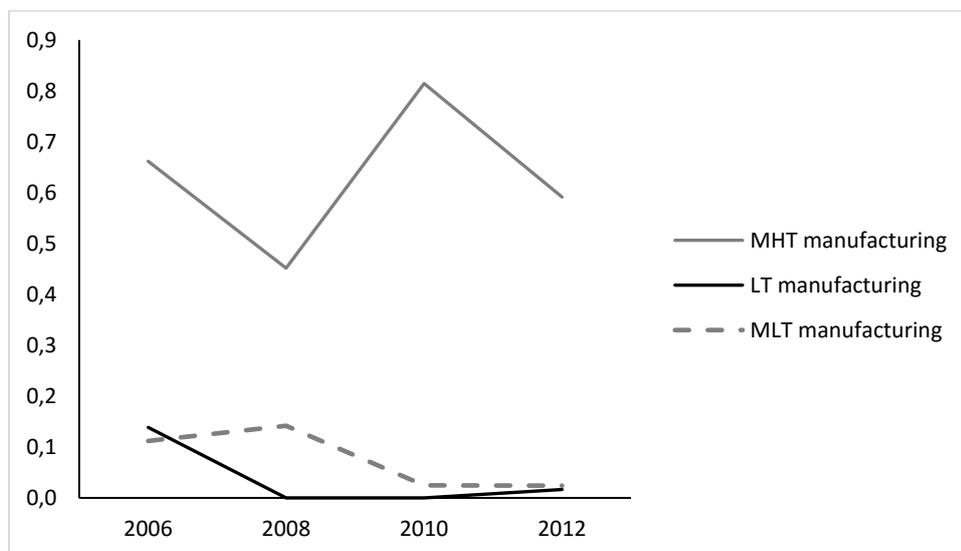


Figure 13-8 below depicts the largest contributors at the beginning of the period. From the figure, it is evident that this peak in local research system collaboration, and in concentration of this activity, is driven by a particularly large contribution from the MHT manufacturing sector during the period 2008-2010. At the same time, the second and third largest contributors in 2004-2006, LT and MLT manufacturing, reduced their relative contribution to local research system collaboration substantially.

Figure 13-9 Sector contribution to local research system collaboration in Telemark. The three largest at the beginning of the period



Consequently, the period has witnessed structural change in the composition of local research system collaboration. Figure 13-9 below demonstrates that the Oil & Gas sector substantially increased its contribution to such collaboration during the period, and accounted, in spite of its relatively small size, for almost 24 per cent in 2010-2012. The differences in contribution from the largest sector (MHT with 59 per cent in 2010-2012), the second largest (Oil & Gas with 24 per cent) and the third largest (Energy & Environment with 6 per cent) illustrate the high levels of concentration exhibited in Telemark.

Figure 13-10 Sector contribution to local research system collaboration in Telemark. The three largest at the end of the period

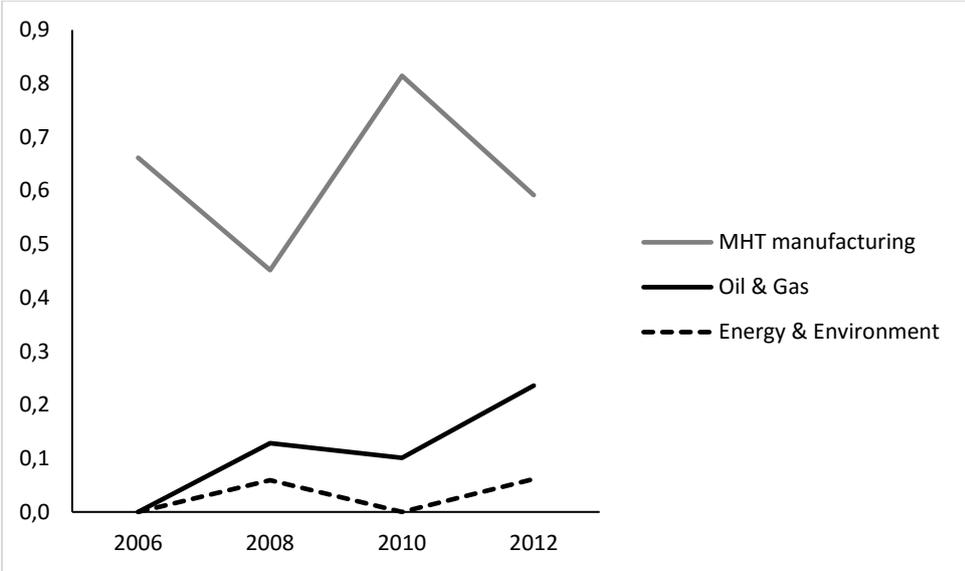
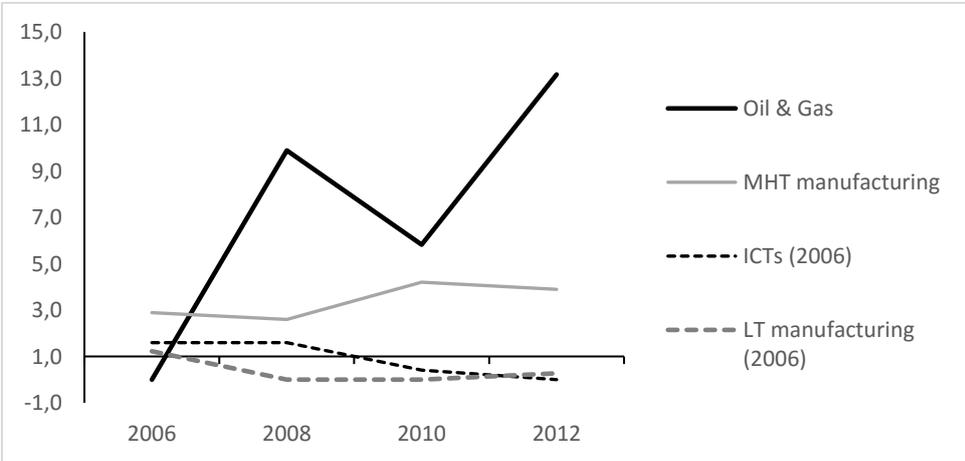


Figure 13-10 below shows that the Oil & Gas sector contributed at the end of the period 13 times more to local research system collaboration, than would be expected from its size. The Commitment of MHT manufacturing increased slightly from 3 times more at the beginning of the period to 3.9 times at the end; while the ICT sector and the LT manufacturing sectors reduced their respective commitments substantially. This raises the question of whether these two sectors have been “crowded out” from local research system collaboration by the Oil & Gas sector and technology providers to this sector that operate in the MHT manufacturing sector.

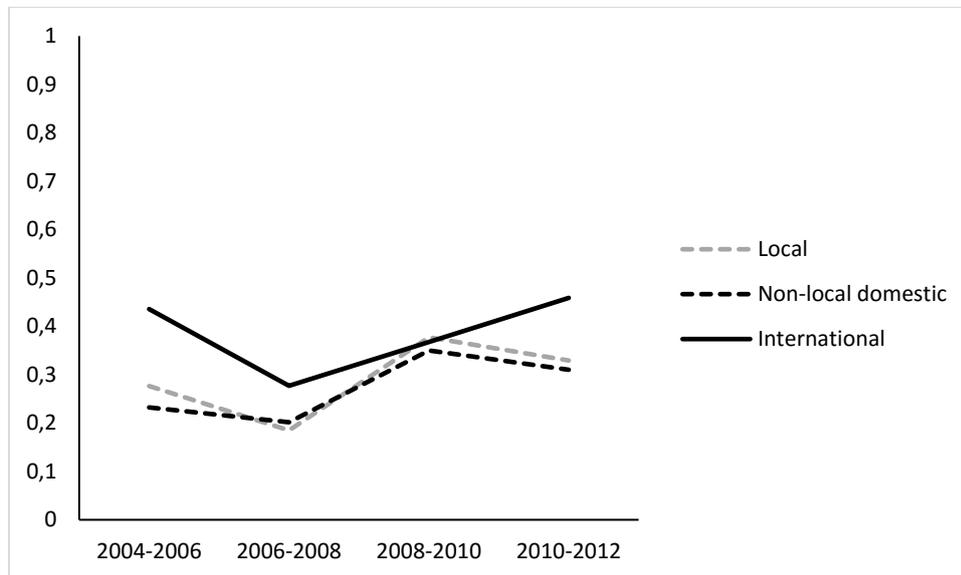
Figure 13-11 Sector commitment to local research system collaboration in Telemark. The three most committed at the beginning and end of the period. One sector is not reported for data disclosure reasons



13.5 The broad definition of RIS: Local inter-firm linkages

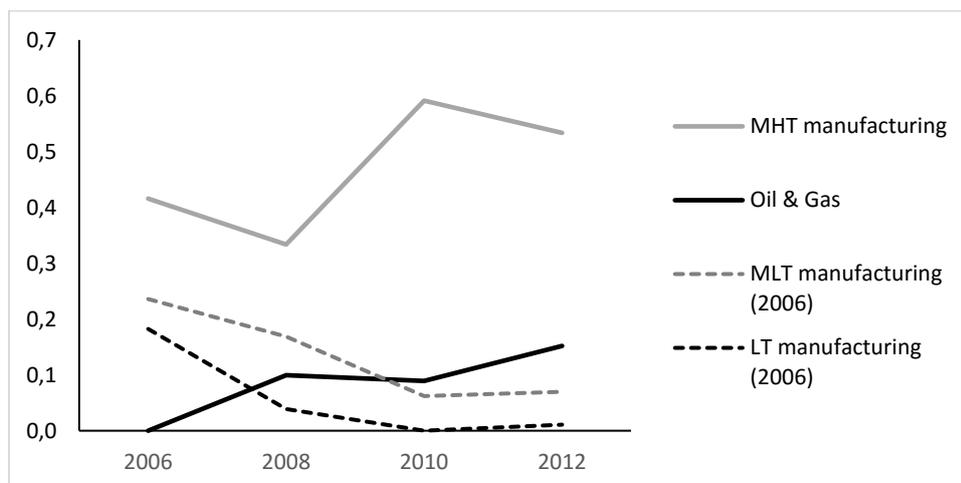
As was the case for local research system collaboration, the sectorial concentration of industrial collaboration has increased during the period. Notably, local and non-local domestic collaboration have evolved in parallel, suggesting that collaboration at the two spatial scales tend to co-exist and that it is dominated by the same industrial sectors.

Figure 13-12 Sector concentration of industrial collaboration in Telemark



Local industrial linkages are dominated by MHT manufacturing. The Oil & Gas sector entered the region at the beginning of the period, and grew to become the second largest contributor at the end of it. In parallel with this, the relative contribution from the MLT and LT manufacturing sectors declined steadily and the latter was more or less absent from local collaboration at the end of the period. Notably, the ICT sector, which is among the largest contributors of innovation-active employment, is not among the top three contributors.

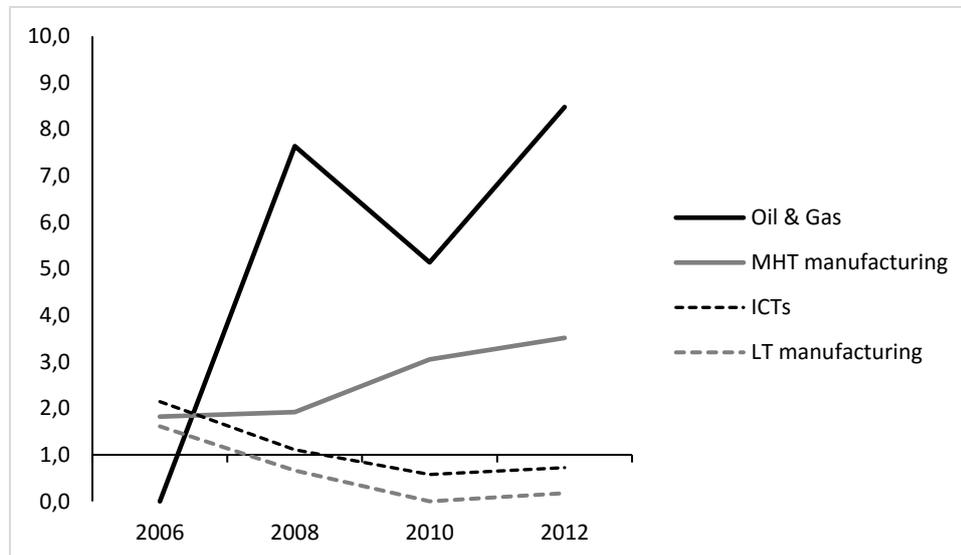
Figure 13-13 Sector contribution to local industrial collaboration in Telemark. The three largest at the beginning and end of the period. One sector is not reported due to data disclosure concerns.



In parallel with what was observed for local research system collaboration, the commitment of the ICT sector and the LT manufacturing sector decreased steadily throughout the period. The former is highly notable and reason for concern, because it means that the third largest contributor of innovation-active employment in the region (the ICT sector) is decoupled from the local collaboration networks that are

dominated by Oil & Gas and MHT manufacturing both along the science system dimension and along the industrial dimension.

Figure 13-14 Sector commitment to local industrial collaboration in Telemark. *The three largest at the beginning and end of the period. One sector excluded due to data disclosure concerns.*



13.6 Summary

During the period, the gap between expected and observed innovation activity grew. This means that the micro-foundations for RIS were weakened. The large contribution and strong commitment of the MHT manufacturing sector to innovation activity must be understood against the background of the sharp increase in the commitment of the Oil & Gas sector to regional innovation, as the former sector contain technology suppliers to the latter. At the end of the period, these two sectors dominated local linkages and the Oil & Gas sector contributed 13 times more human resources to local research system collaboration than would be expected from its size.

In parallel, the ICT sector and the LT manufacturing sector reduced substantially their commitments to local research system collaboration and local industrial collaboration. This is highly notable and reason for concern, because it means that the third and fourth largest (respectively) contributors of innovation-active employment in the region have been decoupled from the local collaboration networks that have become more dominated by Oil & Gas and MHT manufacturing both along the science system dimension and along the industrial dimension.

The Oil & Gas sector and MHT manufacturing sectors are densely skill-related. Presumably, they are also integrated into the same supply chains providing technology & solutions to offshore oil & gas extraction. The increasing dominance of these closely related industries in local collaboration networks, the associated decoupling of the large ICT sector from local collaboration and weak performance in terms of innovation-active employment more generally suggest that a working RIS has not emerged in the region during the period. As local research system linkages in spite of this were strengthened during the period while non-local domestic linkages fluctuated, this indicates development towards a specialised Oil & Gas technology cluster more so than a networked regional innovation system or a regionalized national system.

14 Troms

14.1 Region overview

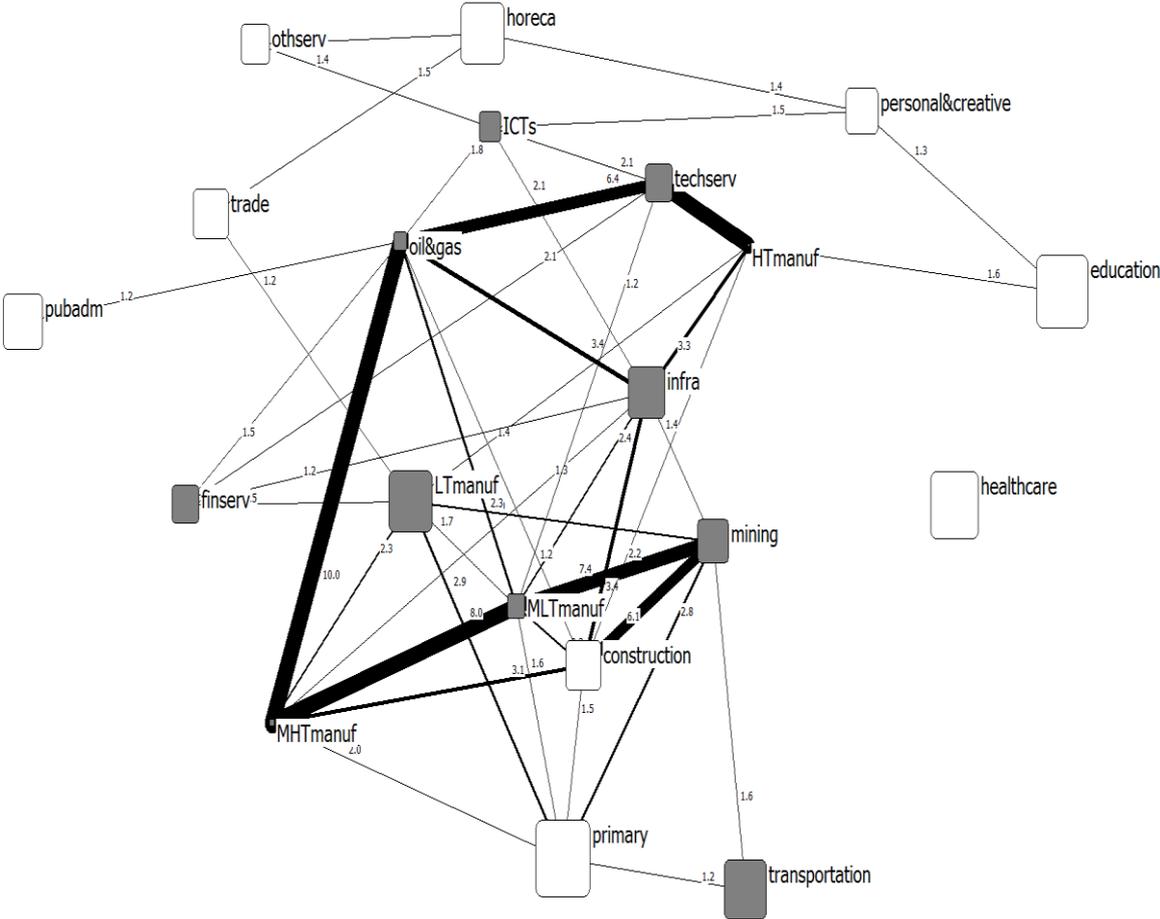
Troms is a small VRI region with weak overall employment growth and over-representation of employment foremost in public sector activities, primary industries and LT manufacturing. The importance of tourism to employment in the region is evident from the location quotient for the HORECA sector. During the period, activity in the Oil & Gas sector expanded strongly, and was paralleled by growth in MLT and LT manufacturing and in Technical & Scientific Services. Employment declined in the primary sector and in high and medium technology-intensive manufacturing.

Table 14-1 Location quotients & growth rates, Troms. Sectors marked with grey are fully covered in the harmonized CIS sample

	Location quotients				Employment growth
	2006	2008	2010	2012	2006-2012
Primary	1,44	1,50	1,49	1,46	-21,20 %
Mining & Quarrying	0,63	0,65	0,69	0,82	46,91 %
Oil & Gas	0,33	0,29	0,24	0,36	106,88 %
HT manufacturing	0,05	0,04	0,04	0,05	-22,73 %
MHT manufacturing	0,19	0,16	0,15	0,14	-28,74 %
MLT manufacturing	0,34	0,37	0,43	0,45	15,99 %
LT manufacturing	0,89	0,92	1,06	1,16	7,88 %
Infrastructure	1,27	1,06	1,02	0,98	-15,85 %
Construction	0,96	0,97	0,94	0,93	7,39 %
Trade	0,89	0,89	0,92	0,93	0,52 %
Transportation	0,89	0,92	1,11	1,11	17,25 %
Horeca	1,08	1,10	1,14	1,16	7,50 %
ICTs	0,59	0,59	0,59	0,56	2,60 %
Financial Services	0,78	0,75	0,73	0,71	-10,05 %
Technical & Scientific services	0,75	0,72	0,74	0,71	11,73 %
Other services	0,80	0,77	0,73	0,75	-0,98 %
Public administration	1,58	1,61	0,96	1,06	-26,72 %
Education	1,36	1,39	1,42	1,40	5,43 %
Healthcare	1,27	1,28	1,32	1,29	5,86 %
Personal & Creative	0,80	0,82	0,88	0,88	17,42 %
Total	3,28 %	3,20 %	3,06 %	3,08 %	1,57 %

The large LT manufacturing and primary sectors of Troms exhibit moderate levels of skill-relatedness between each other, and with other domains of the economy that include Mining & Quarrying and MHT manufacturing. The MLT manufacturing sectors which experienced healthy growth during the period emerge as strongly skill-related to the MHT manufacturing sectors in which employment declined, and to Mining in addition to the Oil & Gas sector. The smaller HT manufacturing and Technical & Scientific Services industries are densely skill-related with each other, and the latter again with the Oil & Gas sector. Notably, a comparatively large Infrastructure, Energy & Environment sector emerge as relatively strongly skill-related with Oil & Gas, HT manufacturing and Construction, in addition to exhibiting more moderate degrees of relatedness within industries ranging from ICTs to Mining & Quarrying.

Figure 14-1 Skill-relatedness revealed by local labour market mobility in Troms, 2002-2012. Line thickness expresses the ratio of observed local mobility over expected mobility, i.e. the degree of revealed skill relatedness. Node size signifies location quotients. Grey nodes are sectors included in the innovation analysis. Only linkages where observed/expected > 1.1 are depicted



14.2 Baseline innovation profile

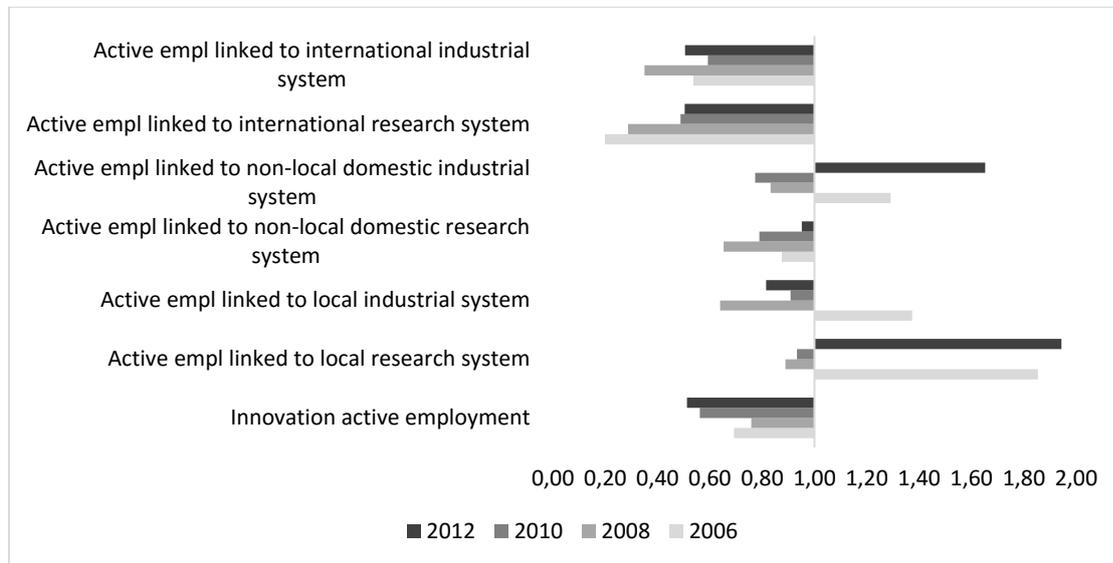
The first line in Table 14-1 below gives the number of establishments in Troms that belong to enterprises sampled by the CIS. The second line gives the number of establishment that the sample represents, i.e. the population size estimated based on sampling weights provided by Statistics Norway. Due to the small size of the region and the low number of CIS observations, reported statistics must be interpreted with caution.

Table 14-2 Number of establishment-level observations

	CIS2006	CIS2008	CIS2010	CIS2012
Unweighted (sample)	304	283	284	297
Weighted (population)	566	525	549	539

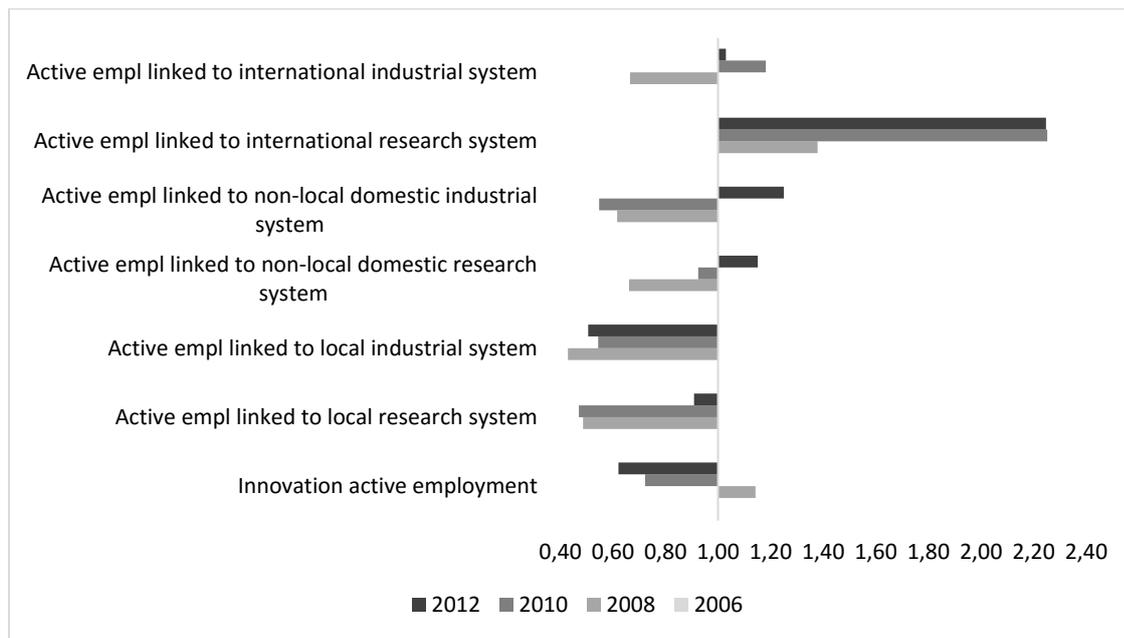
Compared to the national averages (Figure 14-2) and to itself in 2004-2006 (Figure 14-3), Troms under-perform in terms of innovation activity and is estimated to exhibit a dramatic decline in the proportion of employment that occurs in active firms.

Figure 14-2 Innovation profile Troms, relative to Norway = 1



In figure 14-2 below, there are indications of a positive trend in international research system collaboration. Still, this is paralleled by fluctuations in non-local domestic collaboration, and local collaboration levels that remained below those initially exhibited and fluctuating strongly compared to the national averages (Figure 14-1). Thus, indicators of systematic linkages are weak, and trends are unclear.

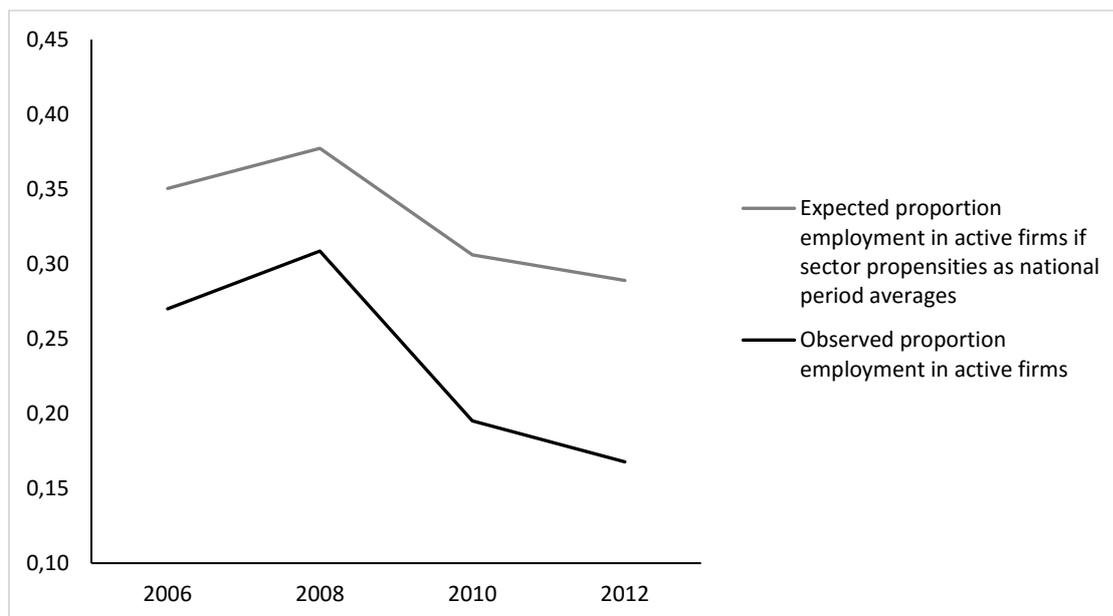
Figure 14-3 Innovation profile Troms, relative to region in 2006 = 1



14.3 The micro-foundations for RIS

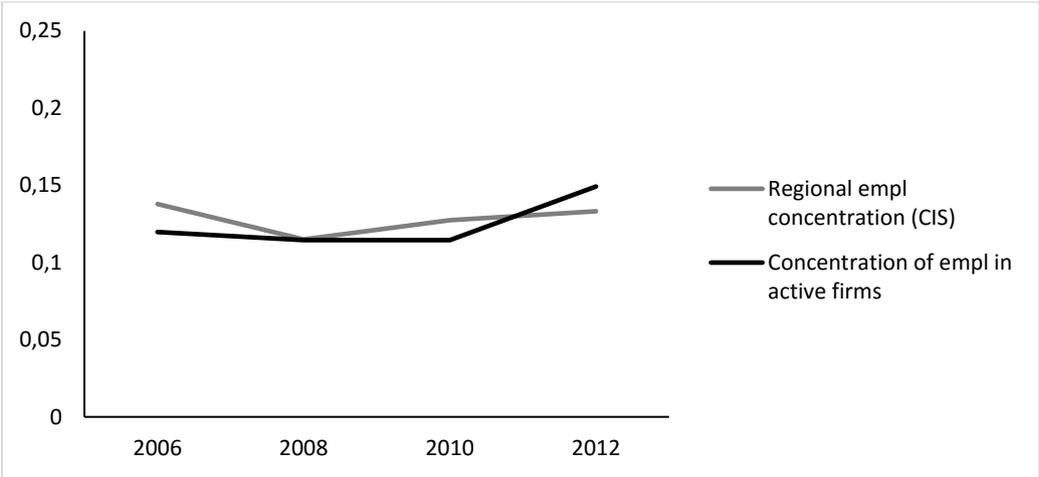
From Figure 14-4 below, it is evident that Troms exhibited a large increase in the gap between expected and observed innovation activity. The decline observed activity was steady through the three later stages of the period considered, and brought innovation activity levels down to the lowest exhibited by any of the 15 VRI regions. Thus, broader mobilisation of firms into development work is a primary, and pressing, challenge for Troms.

Figure 14-4 Observed vs. expected innovation activity in Troms



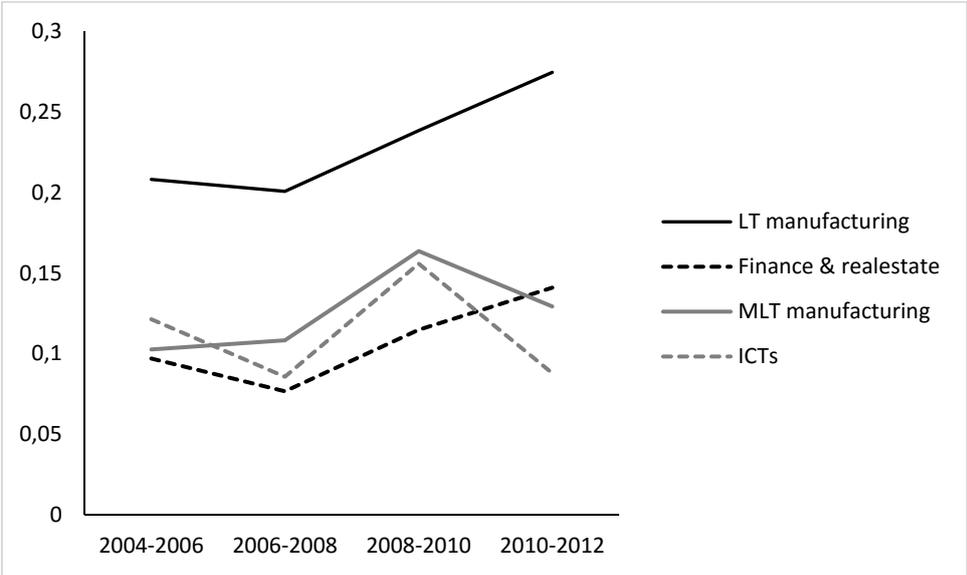
During the first three stages of the period, innovation-active CIS employment was less concentrated than CIS employment in general. This phenomenon is unique to Troms, and suggests that exceptionally low levels of innovation activity are related to the absence of large 'flagship' innovation-active sector in the region.

Figure 14-5 Concentration of innovation active employment in Troms



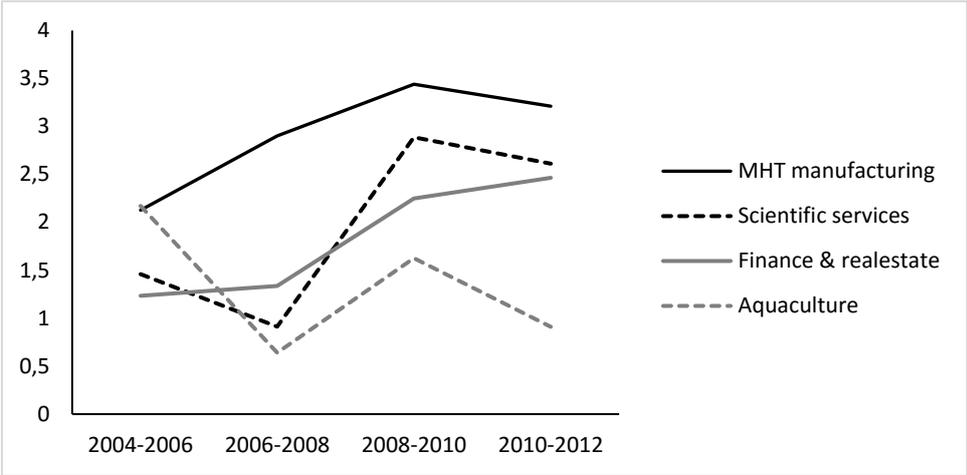
Underscoring this point further is Figure 14-5, from which it is evident that LT manufacturing as the largest contributor of innovation active employment only accounted for 27 per cent of this employment at the end of the period. The second largest contributor at the beginning of the period, the ICT sector, accounted then for 12 per cent, but was down to 9 per cent at the end of it. By contrast, the Finance & real-estate sector increased its relative contribution from 10 per cent at the beginning of the period to 14 per cent at the end of it, placing it as the second largest contributor.

Figure 14-6 Sector contribution to innovation-active employment in Troms. The three largest at the beginning and end of the period



Of the largest contributors, only Finance & real-estate rank among the most committed and the sector contributed at the end of the period 2.5 times as much active employment as would be expected from its size. The commitment of the aquaculture sector declined sharply, while the MHT manufacturing and Technical & Scientific Services sectors exhibited relatively stable increases in their commitment to innovation in Troms. The small HT manufacturing sector, which include the regions' activities in pharmaceutical applications of marine biotechnology, does not rank among the most committed.

Figure 14-7 Sector commitment to innovation activity in Troms. *The three most committed at the beginning and end of the period*



14.4 The narrow defintion of RIS: Local research system linkages

During the period, Troms experienced an increase in the sectorial concentration of research system linkages from 0.14 to 0.25. Non-local domestic linkages became somewhat less concentrated, while international linkages where strongly dominated by a limited number of sectors, with a peak of 0.73 in 2006-2008. In this wave of the CIS, only two industrial sectors reported such collaboration and one of these sectors where completely dominant in terms of employment size.

Figure 14-8 Sector concentration of research system collaboration in Troms

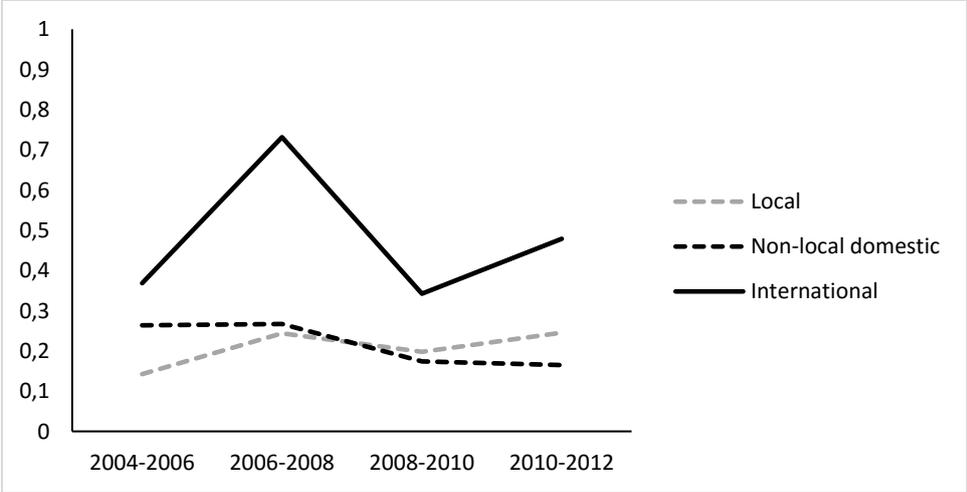


Figure 14-9 below demonstrates that ICTs accounted for a large proportion of employment in firms with a local research system linkage and that the contribution of this sector increased from 11 per cent at the beginning of the period to 18 per cent at the end of it, with a peak of 30 per cent in 2008-2010. This is remarkable given the relatively small size of the sector. Both at the beginning and at the end of the period, the contribution from this sector was comparable to that of the LT manufacturing sector, which exhibited a more stable increase in contribution during the period. Due to a low number of observations, the identity and contribution of the third largest sector cannot be reported.

Figure 14-9 Sector contribution to local research system collaboration in Troms. *The three largest at the beginning and end of the period. One sector is not reported due to data disclosure concerns*

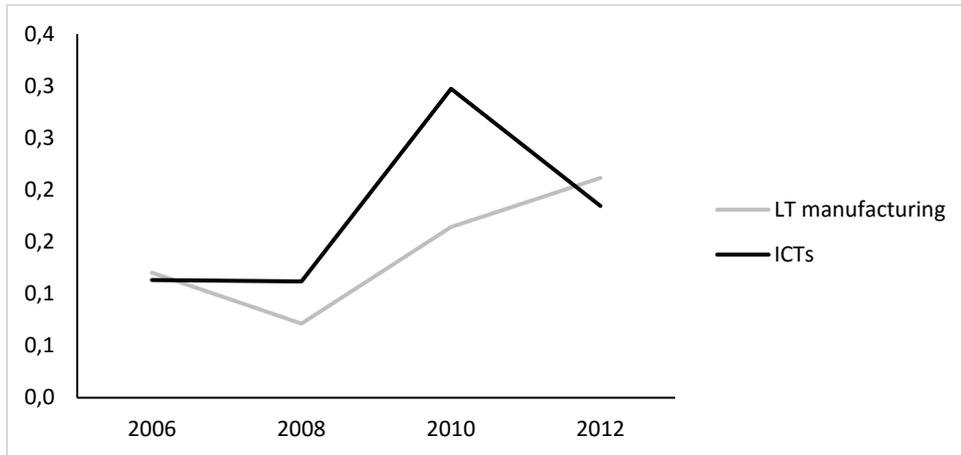
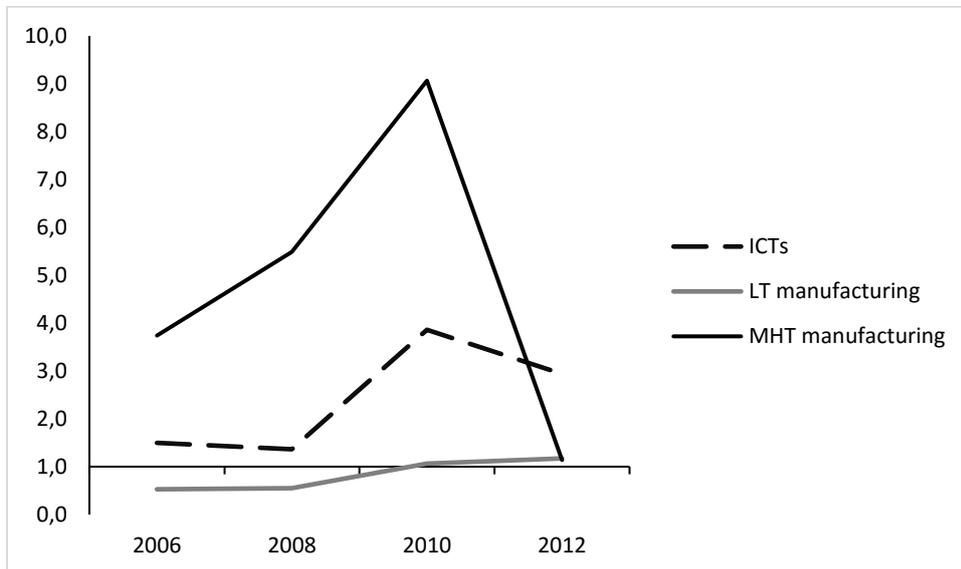


Figure 14-0 below demonstrates that ICTs is the only industrial sector which at the end of the period exhibit a clear commitment to local research system collaboration. While ICTs contributed 2.9 times more than would be expected from its size, the second and third most committed sectors, LT manufacturing and MHT manufacturing, contributed only 1.14 times as much. While the low number of observations suggest that caution is warranted when interpreting this, the sharp decline in commitment from the MHT manufacturing sector is notable because it follows in the wake of a period with exceptionally high commitment levels.

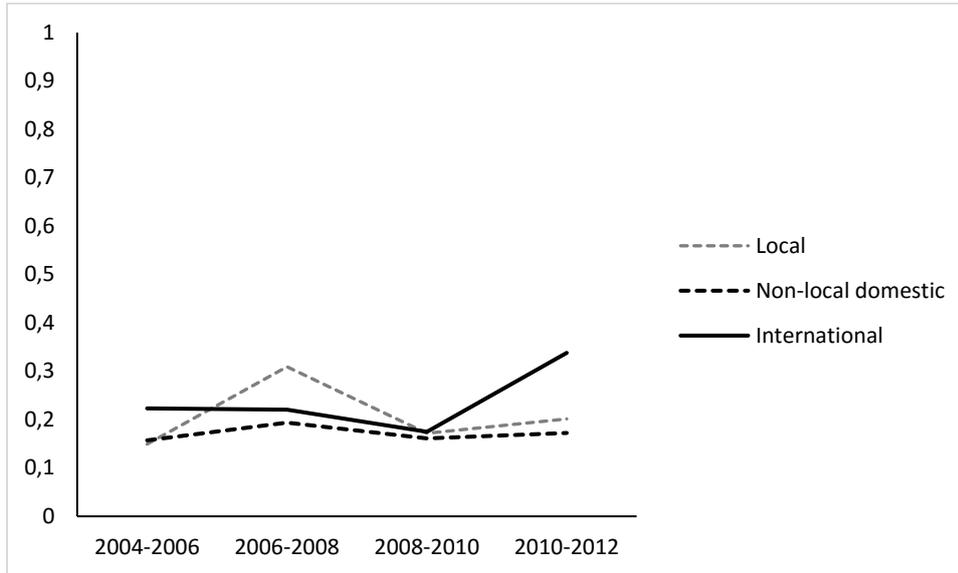
Figure 14-10 Sector commitment to local research system collaboration in Troms. *The three most committed at the beginning and end of the period*



14.5 The broad definition of RIS: Local inter-firm linkages

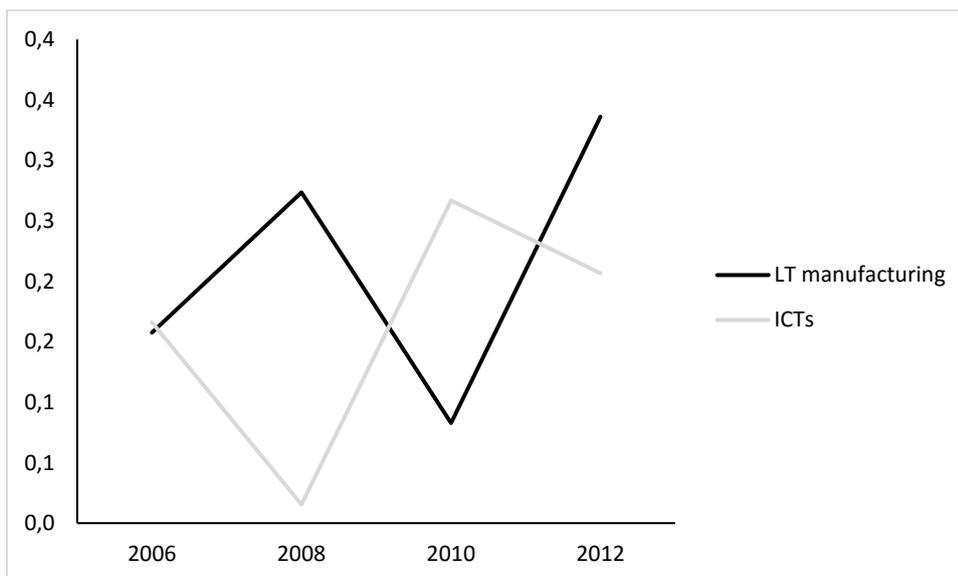
Figure 14-10 below illustrates that the concentration of non-local, domestic industrial network linkages remained stable throughout the period. The concentration of local linkages peaked in 2006-2008; when the relative contributions of the LT manufacturing sector and ICT sector were particularly high and low, respectively (cf. Figure 14-11). The concentration of linkages to international industrial networks increased notably at the end of the period.

Figure 14-11 Sector concentration of industrial collaboration in Troms



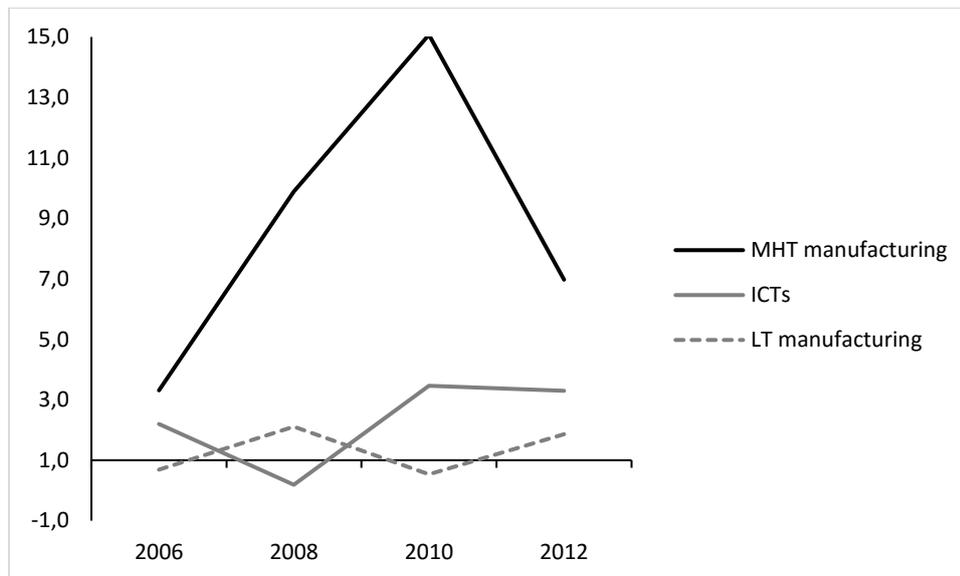
At the end of the period, the LT manufacturing and ICT sector accounted for 34 and 20 per cent respectively of employment occurring in firms with local industrial network linkages (Figure 14-14). This mirrors the dominance of these two sectors also in local networks involving research system institutions.

Figure 14-12 Sector contribution to local industrial collaboration in Troms. *The three largest at the beginning and end of the period. One sector is not reported due to data disclosure concerns*



With the exception of 2006-2008, the ICT sector remained throughout the period the second most committed to local industrial collaboration. The strong increase and subsequent decline in the commitment of the MHT manufacturing sector that was detected for research system collaboration is evident also for local industrial collaboration; yet, in contrast to what was the case for research system collaboration, the sector remained strongly committed to industrial collaboration at the end of the period and contributed almost 7 times as much to such networks as would be expected from its size. Thus, the local industrial networks formed around this sector appear to be more durable.

Figure 14-13 Sector commitment to local industrial collaboration in Troms. The three largest at the beginning and end of the period



14.6 Summary

Troms exhibited weak employment growth during the period, and is specialised foremost in industries with a low technology content. The Oil & Gas sector grew strongly during the period, and established strong skill-relatedness with Technical & Scientific Services and MHT manufacturing. While generally innovation active, these are sectors with limited activity in the region. Overall, innovation activity declined sharply during the period, and the region established itself as that with the lowest estimated proportion of employment engaged in active firms.

Particularly weak micro-foundations for RIS construction are also evident from the growing gap between expected and observed innovation activity. Compared to the national average, local industrial and research system collaboration fluctuated strongly during the period, while the region more consistently strengthened the linkages to international research system institutions that were at the outset weak. All this is contrary to the emergence of a regional networked innovation system or territorially embedded innovation network, and weak, fluctuating non-local domestic collaboration is contrary to regionalization of the national innovation system.

The ICT sector is among the largest contributors of innovation-active employment, and employment with a local research system or industrial system linkages. While there is only limited regional employment in this sector and growth was relatively weak during the period, this is notable because it contradicts the national trend of decreasing contributions and commitments from ICTs to local research system collaboration. Beyond this, local networks are strongly dominated by the LT manufacturing sector. Moreover, it is notable that a relatively large Oil & Gas sector, which is strongly skill-related to MHT manufacturing, is neither among the most committed to regional innovation in general or to regionally networked innovation in particular.

15 Trøndelag

15.1 Region overview

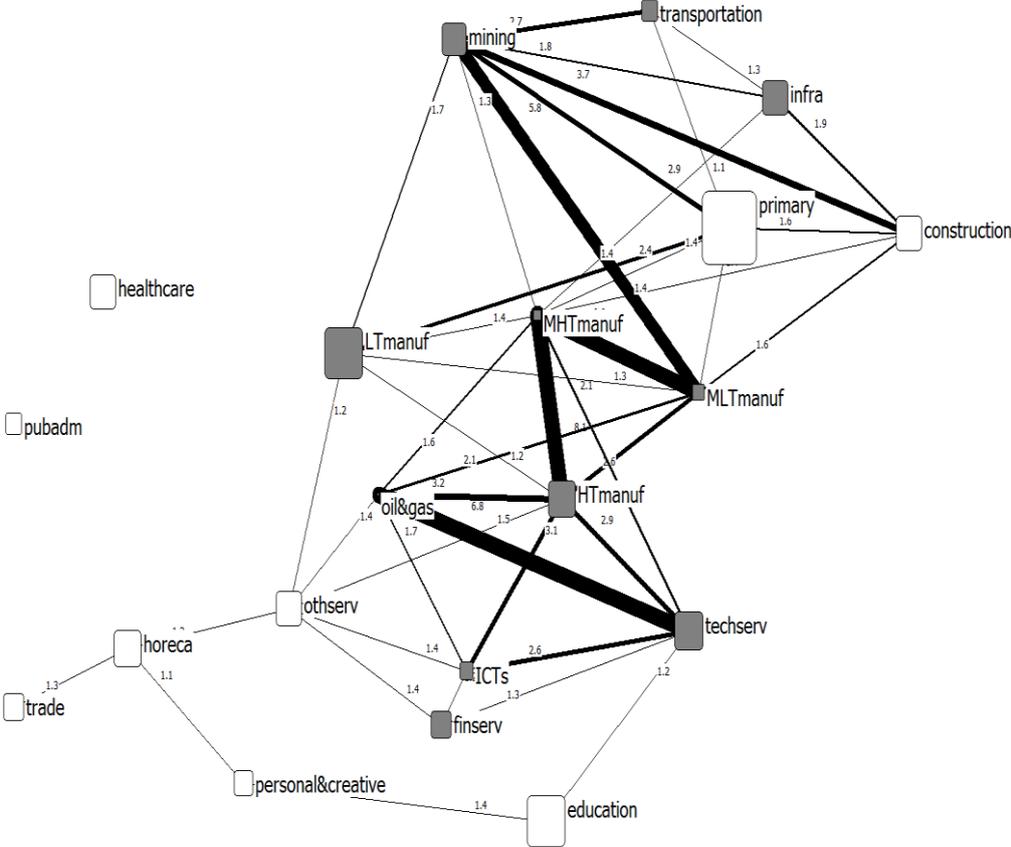
The VRI region of Trøndelag contains the fourth largest city in Norway, which hosts the dominant technical university and one of Europe's largest applied research institutes. The region experiences strong overall employment growth in the period, and particularly strong growth in Oil & Gas, ICTs, Technical & Scientific Services, and in the HT manufacturing sector. At the same time, employment in Primary industries (agriculture, forestry, fisheries & aquaculture) declined.

Table 15-1 Location quotients & growth rates, Trøndelag. Sectors marked with grey are fully covered in the harmonized CIS sample

	Location quotients				Employment growth
	2006	2008	2010	2012	2006-2012
Primary	1,66	1,69	1,70	1,66	-17,31 %
Mining & Quarrying	0,90	1,04	1,01	1,00	34,88 %
Oil & Gas	0,80	0,49	0,58	0,53	34,05 %
HT manufacturing	0,84	1,01	1,05	1,08	17,07 %
MHT manufacturing	0,65	0,66	0,65	0,64	1,26 %
MLT manufacturing	0,73	0,74	0,72	0,73	-7,23 %
LT manufacturing	1,24	1,28	1,27	1,31	-6,86 %
Infrastructure	1,10	1,11	1,09	1,04	8,60 %
Construction	1,07	1,05	1,02	1,04	15,26 %
Trade	0,90	0,90	0,92	0,91	3,75 %
Transportation	0,83	0,81	0,83	0,84	0,74 %
Horeca	1,06	1,06	1,06	1,08	8,47 %
ICTs	0,72	0,75	0,76	0,76	21,27 %
Financial Services	0,92	0,89	0,91	0,93	6,36 %
Technical & Scientific services	1,04	1,10	1,14	1,10	33,23 %
Other services	0,90	0,97	0,94	1,04	30,45 %
Public administration	0,87	0,88	0,83	0,82	10,14 %
Education	1,29	1,29	1,33	1,30	9,47 %
Healthcare	1,05	1,05	1,03	1,04	8,97 %
Personal & Creative	0,91	0,86	0,89	0,88	10,80 %
Totalt	8,59 %	8,52 %	8,39 %	8,58 %	8,22 %

Labour market mobility during the period 2002-2012 reveal strong preferences for mobility within a relatively diverse group of industries that include Oil & Gas, HT, MHT and MLT manufacturing, ICTs, Mining & Quarrying, and Technical & Scientific Services. Notably, the latter sector emerge as skill-related to Education, suggesting there is cross-fertilization between the technical education institutions of the region and the technical services industrial base which in turn is densely related to Oil & Gas. Taken together, this suggest that rich inter-industry cross-fertilization characterizes the regional labour market of Trøndelag.

Figure 15-1 Skill-relatedness revealed by local labour market mobility in Trøndelag, 2002-2012. Line thickness expresses the ratio of observed local mobility over expected mobility, i.e. the degree of revealed skill relatedness. Node size signifies location quotients. Grey nodes are sectors included in the innovation analysis. Only linkages where observed/expected > 1.1 are depicted



15.2 Baseline innovation profile

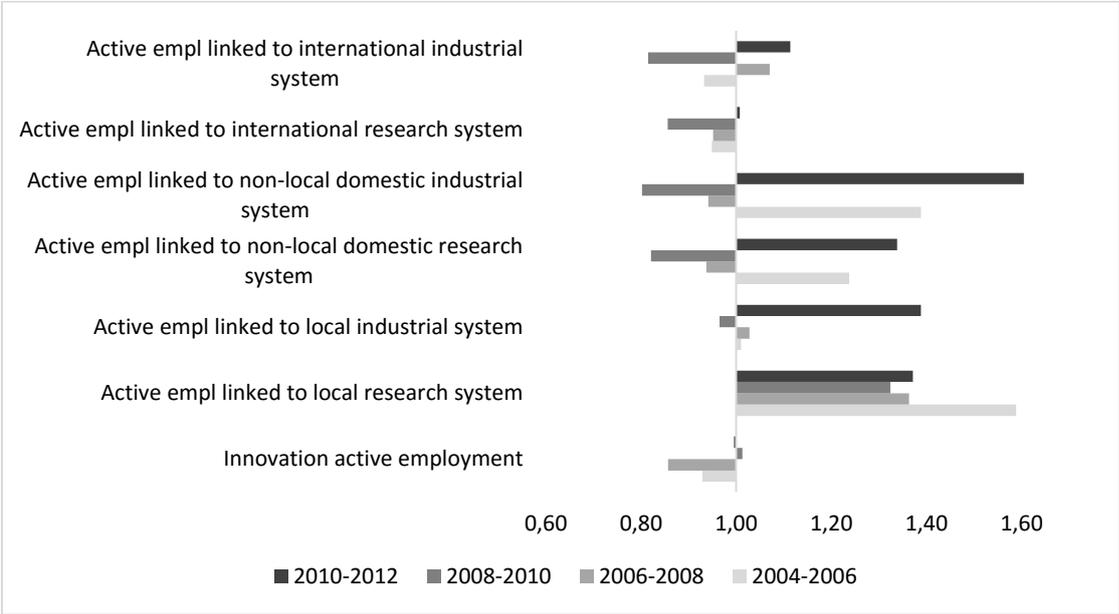
The first line in Table 15-2 below gives the number of establishments in Trøndelag that belong to enterprises sampled by the CIS. The second line gives the number of establishment that those sampled represent, i.e. the population size estimated based on sampling weights provided by Statistics Norway

Table 15-2 Number of establishment-level observations

	CIS2006	CIS2008	CIS2010	CIS2012
Unweighted (sample)	880	819	826	863
Weighted (population)	1749	1572	1507	1527

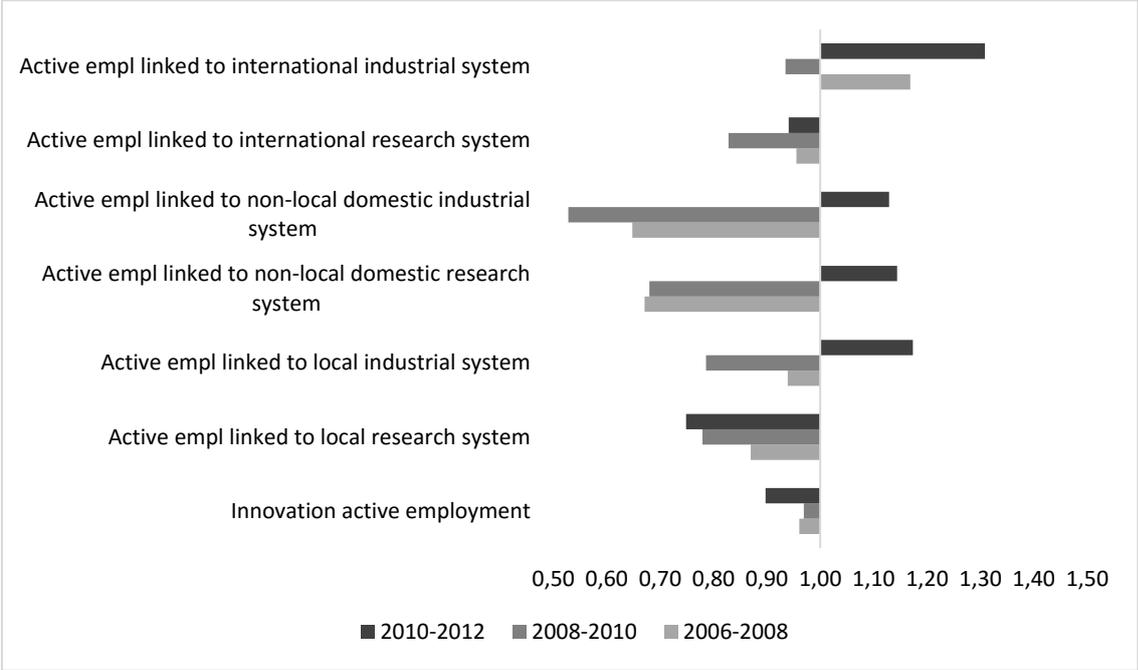
Figure 15-2 below shows that innovation activity declined slightly below the national average during the early phases of the period considered, and then recovered to levels equal to the (declining) national average. Compared to the region itself at the beginning of the period, innovation activity levels were at the end of the period substantially lower than those exhibited initially (Figure 15-3).

Figure 15-2 Innovation profile Trøndelag, relative to Norway = 1



Given the presence of leading technical research institutions, it is not surprising to find that local research system collaboration is consistently above the national averages for the different waves of the CIS. Yet, Figure 15-2 shows that levels have been declining relative to the (declining) national average, and were in 2010-2012 down to 75 per cent of those reported for 2004-2006. This is a consistent trend, which deviate from the fluctuations exhibited along other dimensions of collaboration.

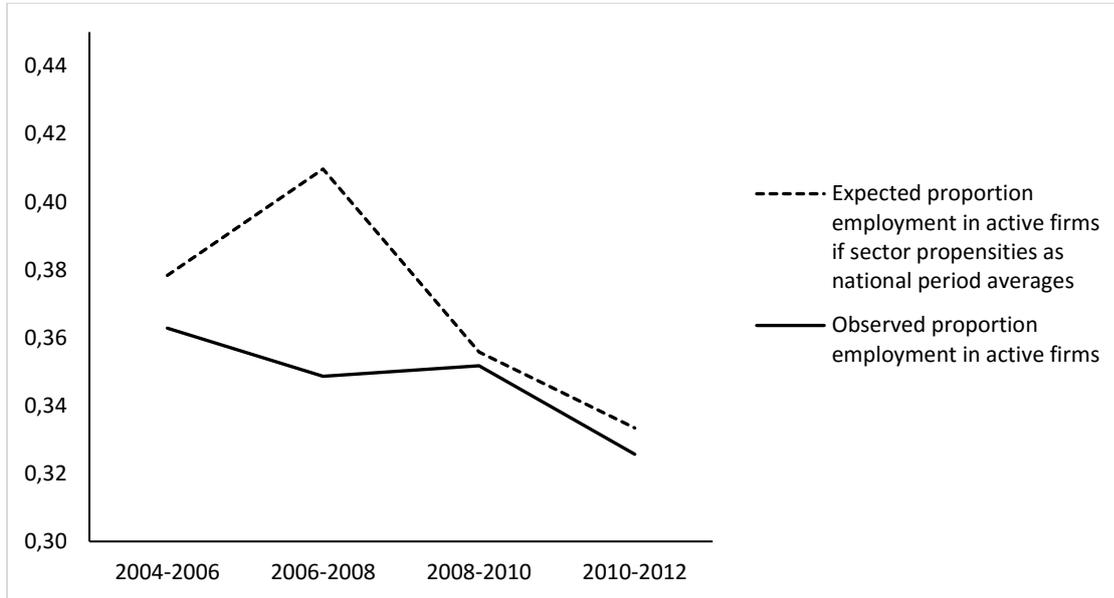
Figure 15-3 Innovation profile Trøndelag, relative to region in 2006 = 1



15.3 The micro-foundations for RIS

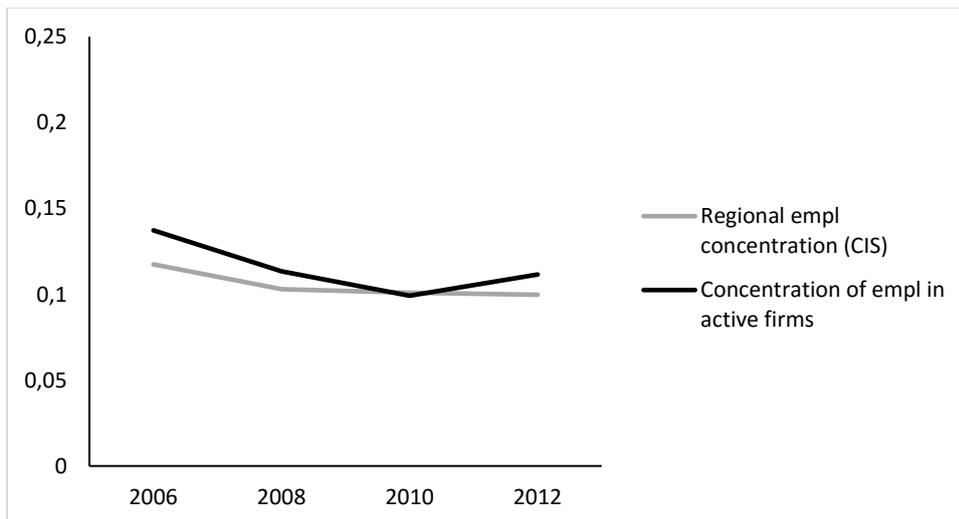
Figure 15-3 shows that the decline in innovation activity described in Figure 15-2 is substantially less than what would be expected given the structural composition of the regional economy and national sector-level trends. This is a clear indication that the micro-foundations for RIS construction in Trondheim are strong.

Figure 15-4 Observed vs. expected innovation activity in Trøndelag



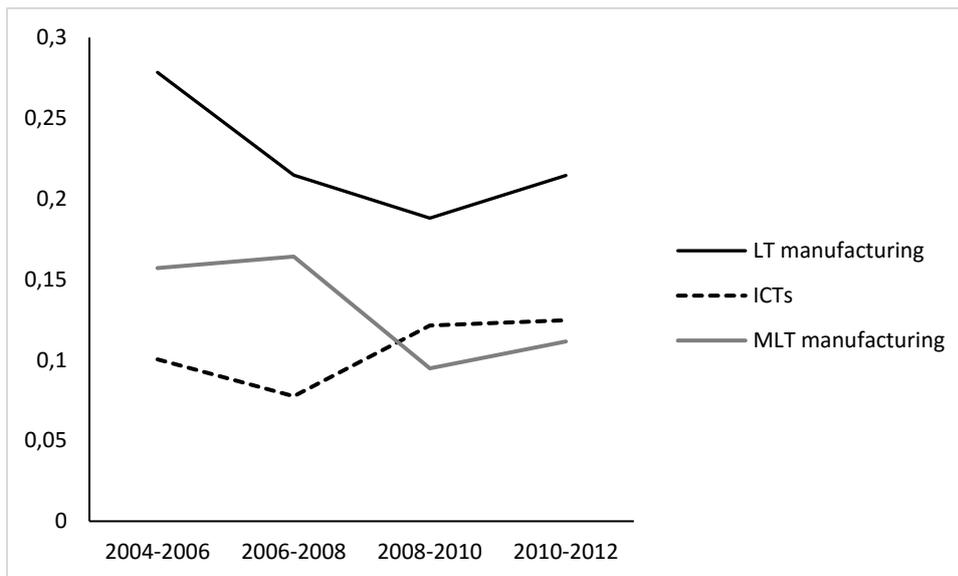
Reflecting the size of the region, CIS employment in general and innovation-active employment in particular is distributed on a relatively large number of industrial sectors. Thus, the micro-foundations for RIS construction are as diverse as the industrial structure itself.

Figure 15-5 Concentration of innovation active employment in Trøndelag



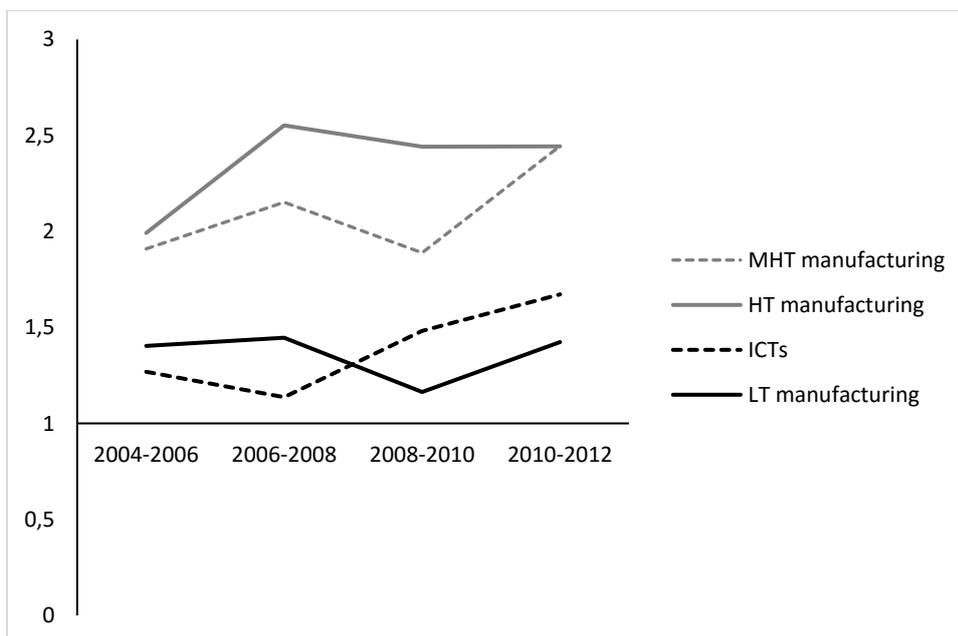
This diversity is evident also in the contribution of different industrial sectors to innovation active employment. Throughout the period considered, LT manufacturing, ICTs and MLT manufacturing remained the three largest contributors yet accounted for only 44 per cent of such employment. The proportion contributed by the two manufacturing sectors decreased, while the relative contribution of the ICT sector increased.

Figure 15-6 Sector contribution to innovation-active employment in Trøndelag. The three largest at the beginning and end of the period



The commitment of the smaller MTH and HT manufacturing to innovation in Trøndelag increased during the early stages of the period, and then stabilized at high levels. The commitment of ICTs also increased notably, and crowded at the end of the period out LT manufacturing from the list of the three most committed.

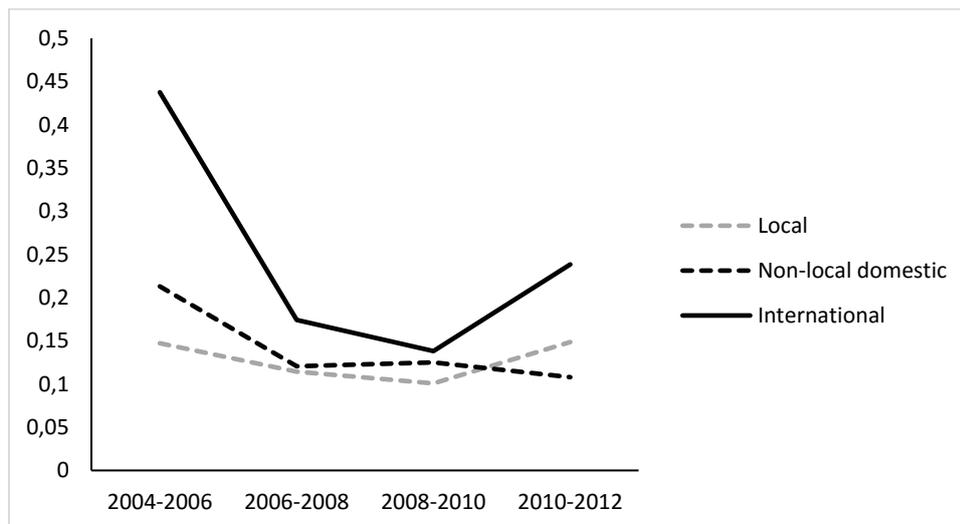
Figure 15-7 Sector commitment to innovation activity in Trøndelag. The three most committed at the beginning and end of the period



15.4 The narrow definition of RIS: Local research system linkages

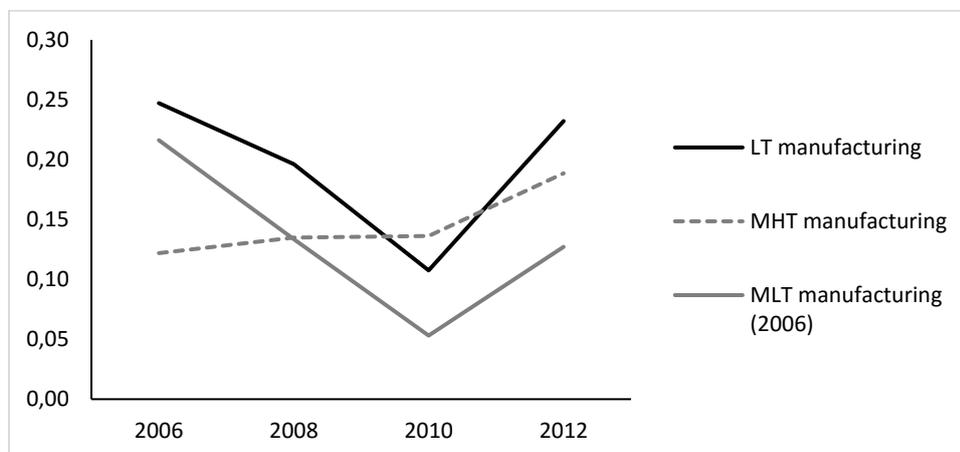
The concentration scores described in Figure 15-7 below shows that local research system linkages in Trøndelag encompasses a broad range of industries. The level of concentration decreased steadily yet moderately during the first stages of the period, but increased somewhat at the end. Notably, international research system linkages were at the beginning of the period highly concentrated, meaning that a limited number of industrial sectors accounted for the 'pipelines' maintained by the region to international research communities. During the subsequent rounds of the CIS, a broader range of industries engaged in international research system collaboration, raising the question of whether this is related to the overall decline in local linkages described in Figure 15-2.

Figure 15-8 Sector concentration of research system collaboration in Trøndelag



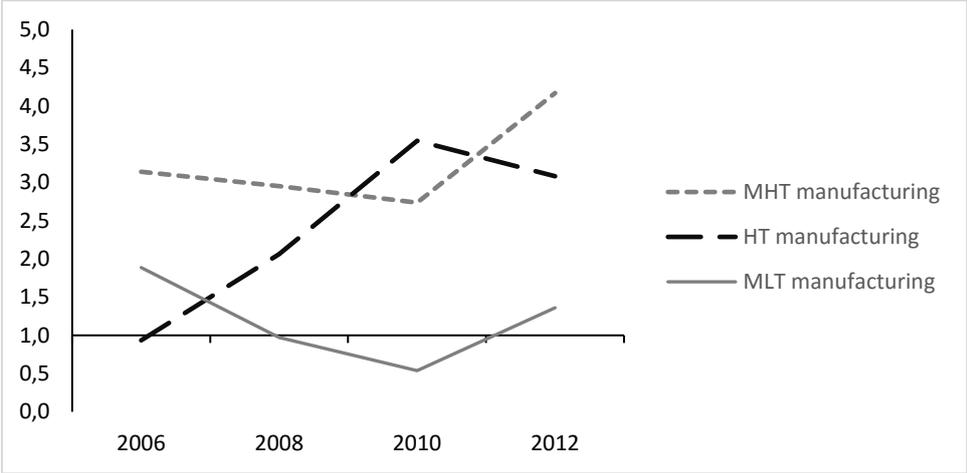
Manufacturing industries are the largest involved in research system collaboration, in addition to one sector for which data cannot be reported due to disclosure rules. Particularly notable is how the growing commitment of the MHT manufacturing sector to innovation activity is paralleled by a steady growth in the contribution to local research system collaboration. By contrast, the large contribution from the ICT sector to innovation activity is not mirrored in the contribution of this sector to local research system collaboration.

Figure 15-9 Sector contribution to local research system collaboration in Trøndelag. *The three largest at the beginning and end of the period. One sector is excluded due to data disclosure concerns.*



The growth in commitment from the technology-intensive manufacturing industries to regional innovation in Trøndelag reflected in strong and relatively consistent growth in the commitment of the two sectors to local research system collaboration (Figure 15-10). In spite of a strong contribution and commitment to regional innovation, the ICT sectors does not figure among the three most committed to local research system collaboration. This adds to the evidence that ICTs during the period considered have withdrawn, or been crowded out, from the local collaboration networks of Norwegian regions

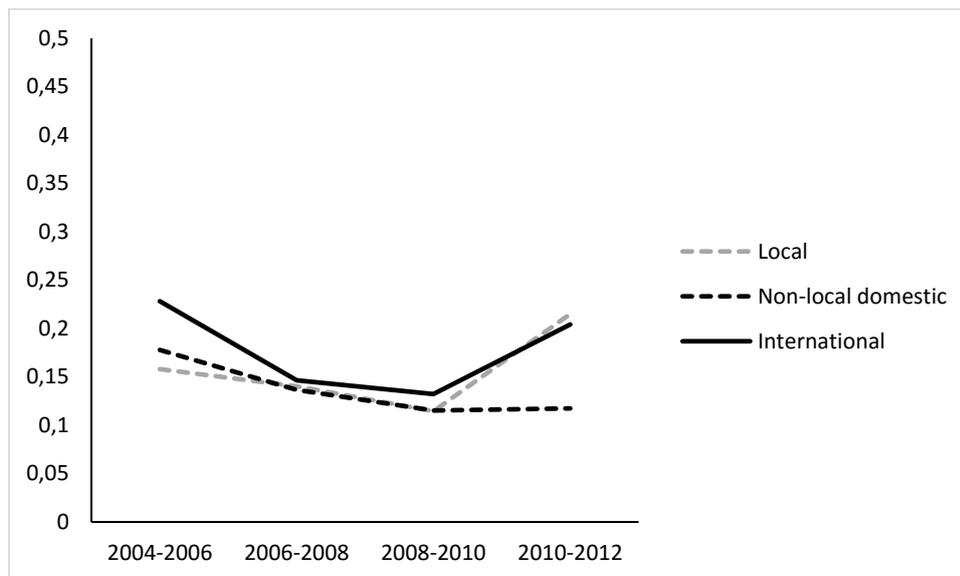
Figure 15-10 Sector commitment to local research system collaboration in Trøndelag. *The three most committed at the beginning and end of the period. One sector excluded due to data disclosure concerns.*



15.5 The broad definition of RIS: Local inter-firm linkages

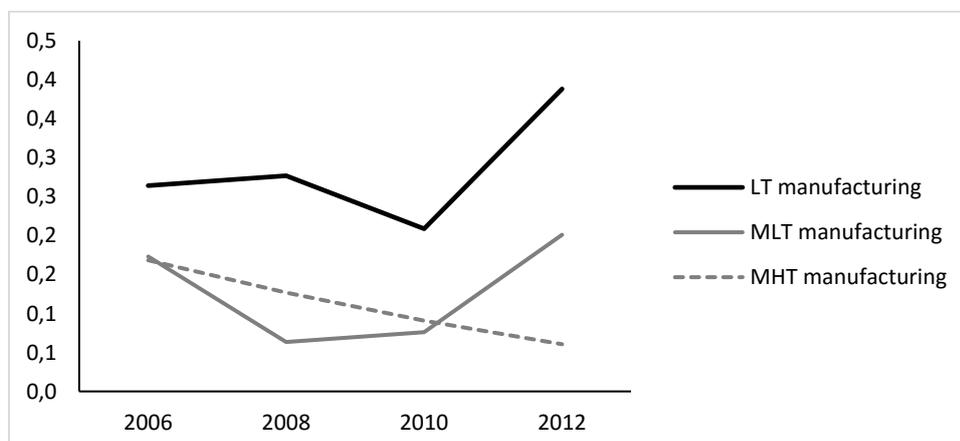
Figure 15-10 below describes that local inter-firm linkages in Trondheim exhibit concentration scores that increased at the end of the period to a level above that exhibited by local research system linkages (Figure 15-7) and comparable to the level of foreign industrial collaboration. This is a relatively unique picture which is reason for concern, because it suggests that relatively broad mobilisation of firms and industries into local research system collaboration (the narrow definition of RIS) is paralleled by weaker direct ties between local firms (the broad definition of RIS). Consequently, a stronger emphasis on the DUI-aspect of regional innovation system construction may be warranted to complement the strength of the region along the STI-dimension.

Figure 15-11 Sector concentration of industrial collaboration in Trøndelag



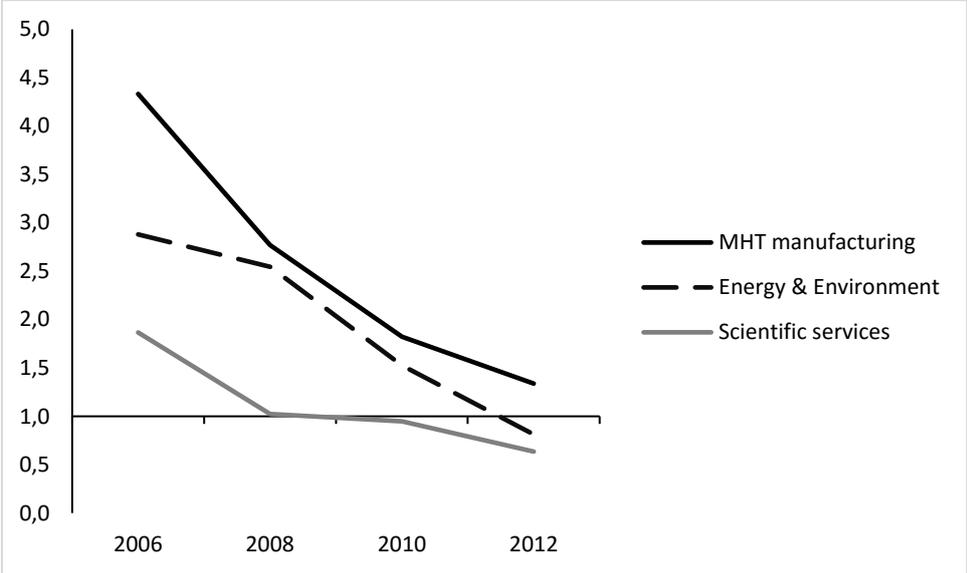
This interpretation is further substantiated by Figure 15-11 below, which describes how the growth in contribution from the MHT manufacturing industry to innovation activity in general and research system collaboration in particular is paralleled by a strong and steady decline in the contribution of this sector to local inter-firm networks. Moreover, Figure 15-12 demonstrates that this is reflected in an even steadier decline in the commitment of the sector. Notably, the LT manufacturing sector appears to be in a unique position in that it is the largest contributor to both local research system collaboration (cf. Figure 15-8) and to local industrial collaboration (Figure 15-11).

Figure 15-12 Sector contribution to local industrial collaboration in Trøndelag. The three largest at the beginning and end of the period



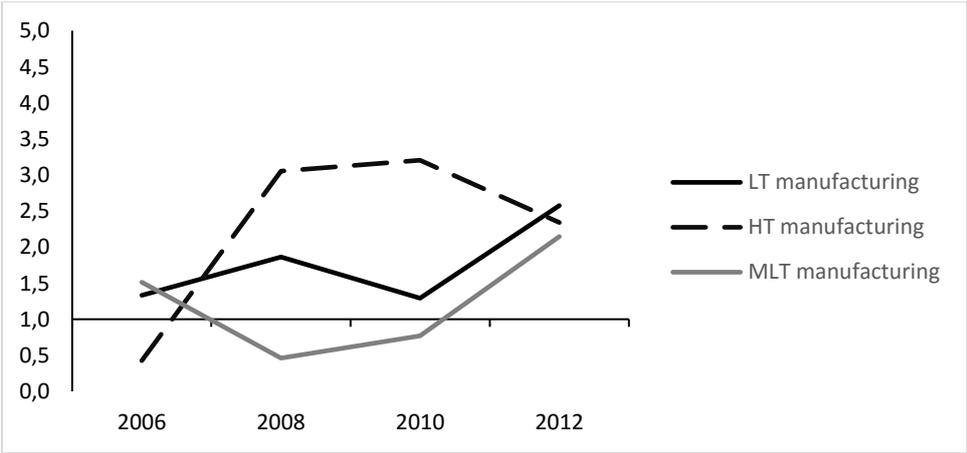
The period considered witnessed a distinct shift in the composition of industries that are committed to local industrial collaboration. Most notably, the Infrastructure, Energy & Environment and Technical & Scientific Services sectors reduces their commitments substantially, and contributed at the end of the period less to local industrial collaboration than would be expected from their size.

Figure 15-13 Sector commitment to local industrial collaboration in Trøndelag. The three largest at the beginning of the period



The HT manufacturing sector, by contrast, strongly increased its commitment to local industrial collaboration. Notably, the LT manufacturing sector, which is the largest measured in terms of overall contribution, was at the end of the period also the most committed and contributed 2.6 times than would be expected from its size. Finally, it is notable that the ICT sector does not figure among the largest contributors or the most committed to local industrial collaboration.

Figure 15-14 Sector commitment to local industrial collaboration in Trøndelag. The three largest at the end of the period



15.6 Summary

While Trøndelag exhibited lower than expected innovation activity levels at the beginning of the period, levels were during the period raised to those that would be expected given the industrial composition of the region and national sector-level trends. Notably, the concentration of innovation-active employment in Trøndelag is not much higher than the concentration of CIS employment as a whole, suggesting that the foundations for RIS construction are also broad. Moreover, broad foundations are reflected in local research system linkages that encompass a diverse range of industries. Thus, while levels of local research system collaboration have decreased consistently during the period, linkages are diverse and as such pointing towards a regional networked innovation system narrowly defined. Still, it is difficult to determine whether these characteristics are derivatives of the larger national innovation system which converge on Trondheim City, or indicative of a 'true' working RIS.

Four aspects of collaborative linkages in Trøndelag warrant additional attention. The first is the unique position of the LT manufacturing sector as largest contributor of innovation active employment, and the largest contributor to local research system networks and local industrial networks. The second, and mirroring, is the unique position of the HT manufacturing sector as the most committed to innovation activity, and most committed to both types of regional networking. Thus, these two rather different sectors, that labour market mobility reveal are only weakly skill-related, have in common that they have positioned themselves at the intersection between research system networks providing support for the STI mode of innovation and industrial networks providing support for the DUI mode. Conversely, and third, the MHT manufacturing sector has withdrawn from local industrial collaboration yet remain highly committed to local research system collaboration. Last, and providing reason for concern, is how the ICT sector that is a large contributor of innovation-active employment is also decoupled from the local collaboration networks that define a working RIS.

16 Vestfold

16.1 Region overview

Vestfold is strongly specialized in the technology-intensive HT and MHT manufacturing industries, and exhibit over-representation of employment also in MLT and LT manufacturing. Employment directly linked to Oil & Gas extraction, by contrast, was limited at the beginning of the period and absent in the registers at the end of it. Sectors exhibiting particularly strong employment growth were ICTs, Technical & Scientific Services, Public Administration and MHT manufacturing.

Table 16-1 Location quotients & growth rates, Vestfold. Sectors marked with grey are fully covered in the harmonized CIS sample

	Location quotients				Employment growth
	2006	2008	2010	2012	2006-2012
Primary	0,68	0,71	0,72	0,69	-19,20 %
Mining & Quarrying	2,53	2,22	1,56	1,51	-29,73 %
Oil & Gas	0,01	0,02	0,00	0,00	(-80 %)
HT manufacturing	3,95	4,05	4,01	4,27	-4,35 %
MHT manufacturing	1,31	1,49	1,37	1,45	9,52 %
MLT manufacturing	1,09	1,03	1,11	1,08	-11,78 %
LT manufacturing	1,19	1,26	1,28	1,32	-5,16 %
Infrastructure	0,82	0,79	0,72	0,69	-5,46 %
Construction	1,17	1,11	1,13	1,10	7,69 %
Trade	1,17	1,17	1,16	1,17	-1,03 %
Transportation	0,79	0,83	0,78	0,79	-2,76 %
Horeca	0,90	0,86	0,87	0,89	2,29 %
ICTs	0,58	0,59	0,63	0,61	17,59 %
Financial Services	0,70	0,73	0,71	0,70	1,61 %
Technical & Scientific services	0,83	0,79	0,80	0,85	24,65 %
Other services	0,94	0,99	0,97	0,92	7,32 %
Public administration	0,84	0,84	0,83	0,82	10,09 %
Education	1,02	1,02	1,06	1,05	8,37 %
Healthcare	1,05	1,07	1,09	1,11	14,06 %
Personal & Creative	0,87	0,85	0,86	0,86	9,77 %
Totalt	4,14 %	4,13 %	4,05 %	4,01 %	5,07 %

16.2 Baseline innovation profile

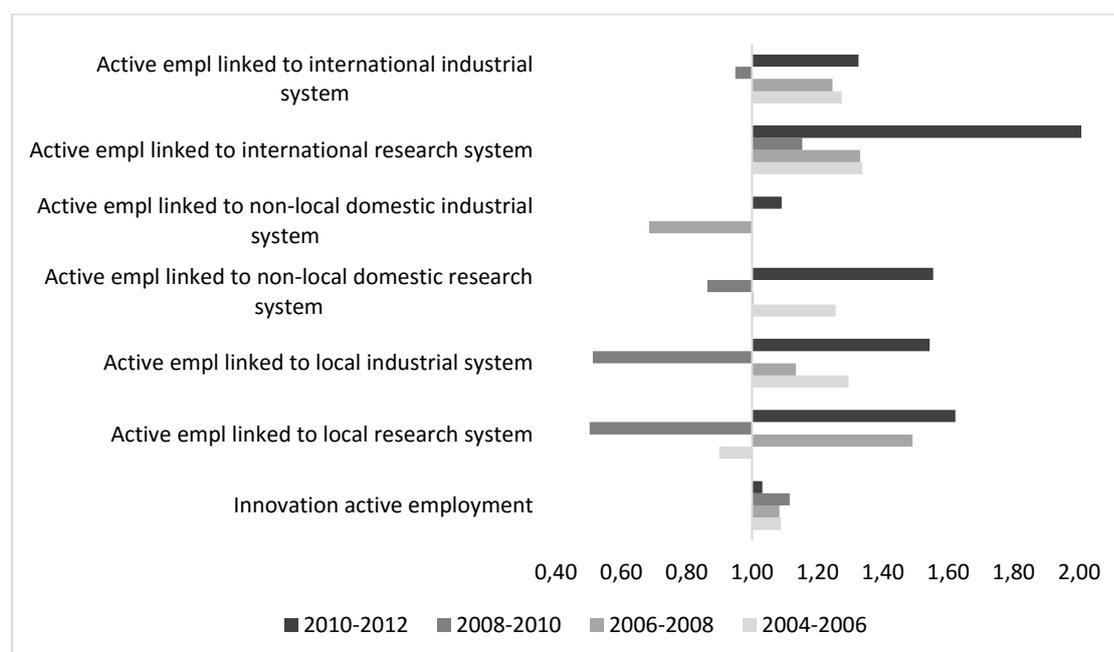
The first line in Table 16-2 below gives the number of establishments in Vestfold that belong to enterprises sampled by the CIS. The second line gives the number of establishment that those that are sampled are meant to represent, i.e. the population size estimated based on sampling weights provided by Statistics Norway.

Table 16-2 Number of establishment-level observations

	CIS2006	CIS2008	CIS2010	CIS2012
Unweighted (sample)	442	429	402	419
Weighted (population)	1040	913	863	865

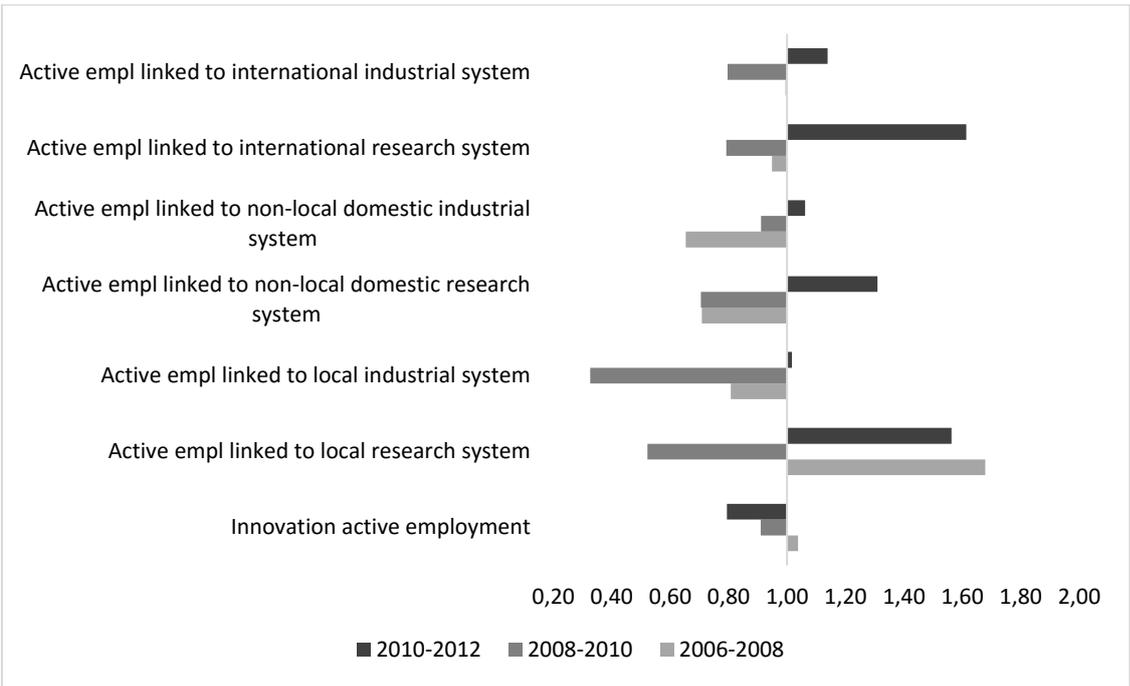
From Figure 16-2 below, it is evident that innovation activity levels in Vestfold have been relatively stable compared to the (declining) national average. Yet, compared to the region itself at the beginning of the period (Figure 16-3), innovation activity declined during the later stages of the period.

Figure 16-2 Innovation profile Vestfold, relative to Norway = 1



The region exhibit strong period-to-period fluctuations in the proportion of active employment that occurs in firms with local research system linkages. This suggests that collaboration is dominated by a limited number of (large) firms, and occurring on a project-to-project basis. Parallel fluctuations in collaboration intensities is also indicative of this, and of interdependencies between different types and geographies of collaboration: In periods where local research system collaboration is above the levels exhibited in 2004-2006, international research system and industrial collaboration is also strong, and vice versa.

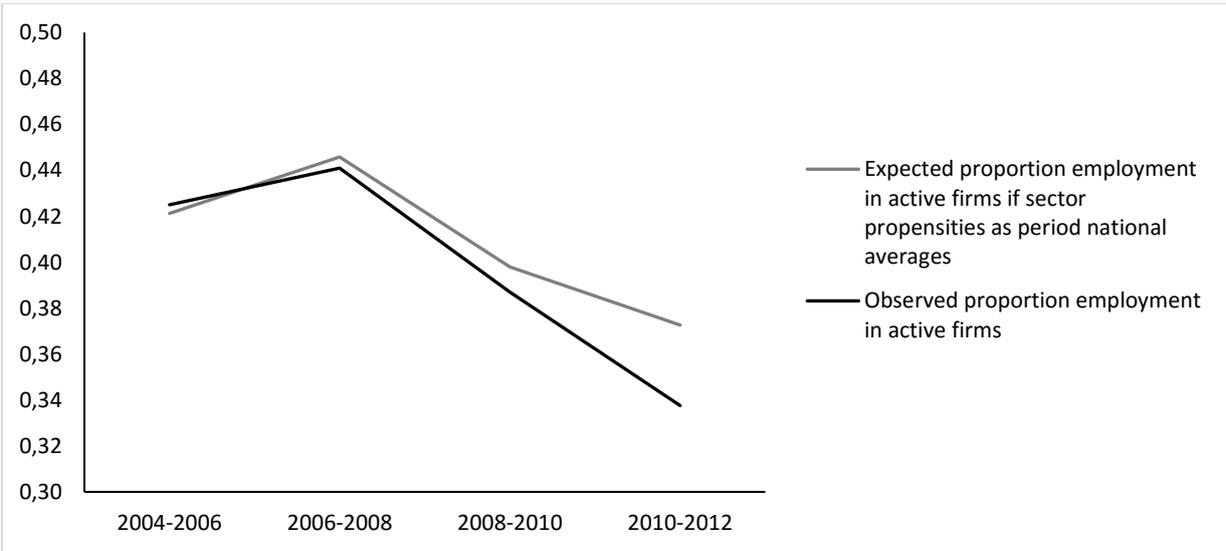
Figure 16-3 Innovation profile Vestfold, relative to region in 2006 = 1



16.3 The micro-foundations for RIS

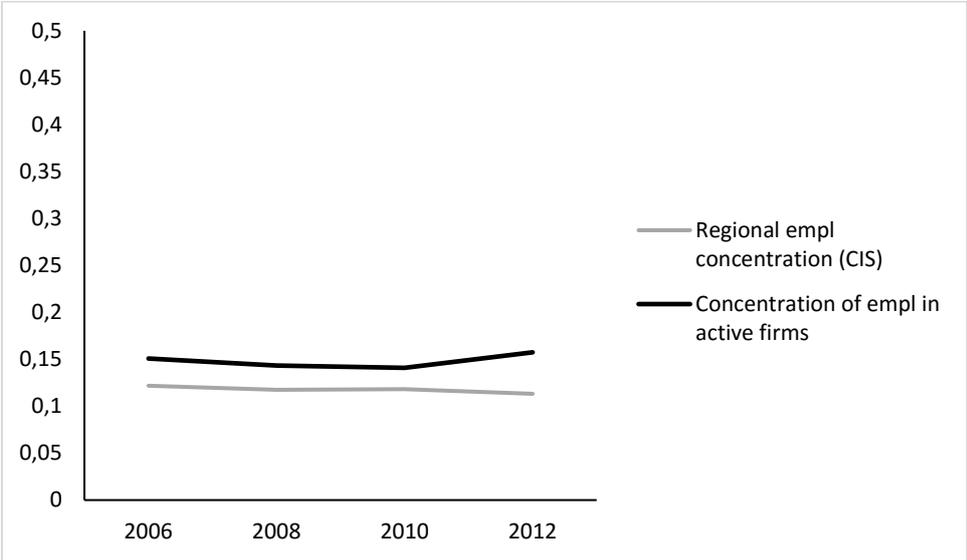
Figure 16-3 demonstrates that high levels of innovation activity are to be expected in Vestfold, given the composition of the industrial structure in the region and national sector-level trends. During most of the period considered, observed levels are equal to expected levels. Still, during the later stages, observed activity started to decline to levels notably below those that were expected. Thus, while the micro-foundations for RIS construction in Vestfold are strong relative to Norwegian averages, they have been consistently weakening during the later stages of the period both in absolute terms and relative to the downward national trend. This is clearly reason for concern.

Figure 16-4 Observed vs. expected innovation activity in Vestfold



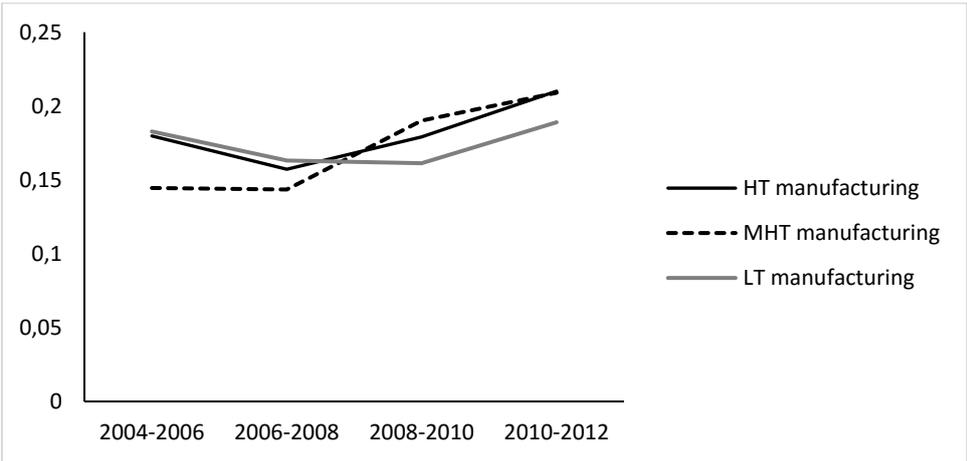
In spite of the comparatively small size of the region, the concentration of innovation-active employment remained stable at levels only slightly above the concentration level exhibited for employment in general (Figure 16-4), albeit with a slight increase at the end of the period. This entails that the micro-foundations for RIS construction are broad.

Figure 16-5 Concentration of innovation active employment in Vestfold



Throughout the period, the three largest contributors of innovation-active employment were HT, MHT and LT manufacturing. All three sectors increased their relative contribution, but did not account for more than approximately 60 per cent of such employment at the end of the period. This is consistent with the low levels of concentration described above and further underscores the diversity of innovation activity in Vestfold.

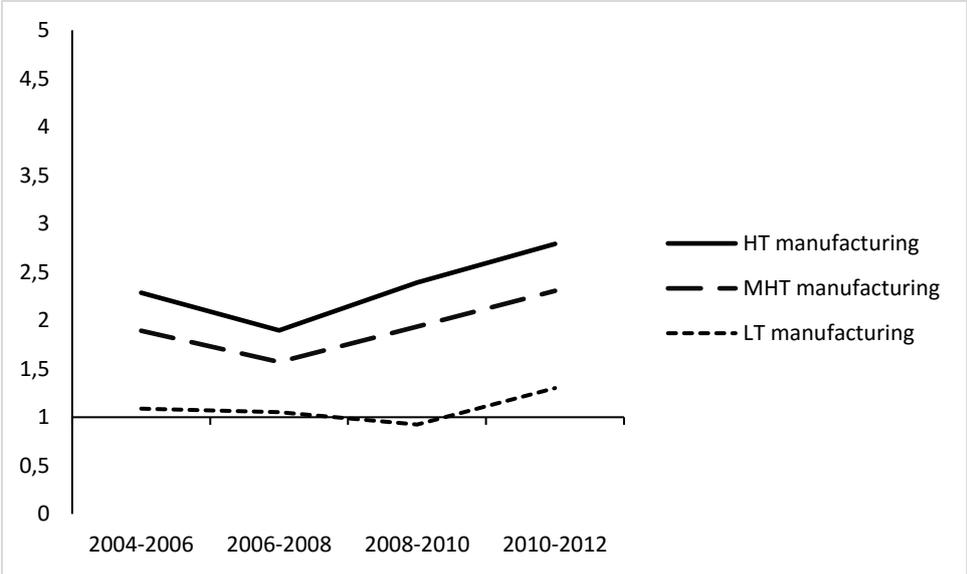
Figure 16-6 Sector contribution to innovation-active employment in Vestfold. The three largest at the beginning and end of the period



HT and MHT manufacturing also exhibited high and stable levels of commitment to regional innovation. While these two sectors contributed 2.7 and 2.3 times more to active employment than would be expected from their size, the third most committed sector that is LT manufacturing only contributed slightly above this level. This means that other industries that are innovation active in Vestfold exhibit relatively low commitment levels and contribute less active employment than would be expected from their size. Consequently, in spite of the relatively diverse innovation active employment base of Vestfold, policy attention dedicated to increasing the commitment of a broader range of

industries to innovation is warranted if the regions' clear potential for the construction of RIS based on diversity is to be captured.

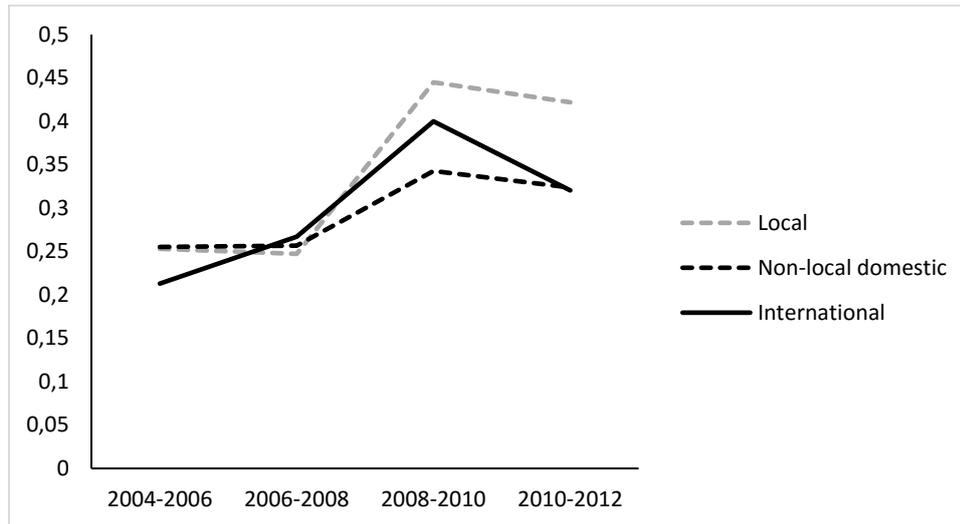
Figure 16-7 Sector commitment to innovation activity in Vestfold. *The three most committed at the beginning and end of the period*



16.4 The narrow definition of RIS: Local research system linkages

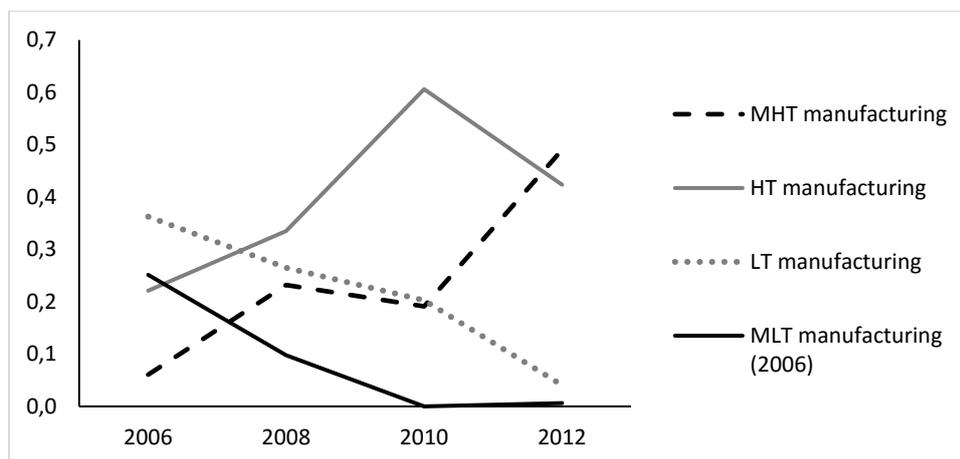
Figure 16-7 below demonstrates that local research system linkages in Vestfold are highly concentrated, i.e. dominated by a limited range of industrial activities, and that concentration levels have been increasing to levels that are well above those exhibited for non-local domestic and international research system collaboration. This mirrors poorly the much more differentiated landscape of regional innovation activity described above.

Figure 16-8 Sector concentration of research system linkages in Vestfold



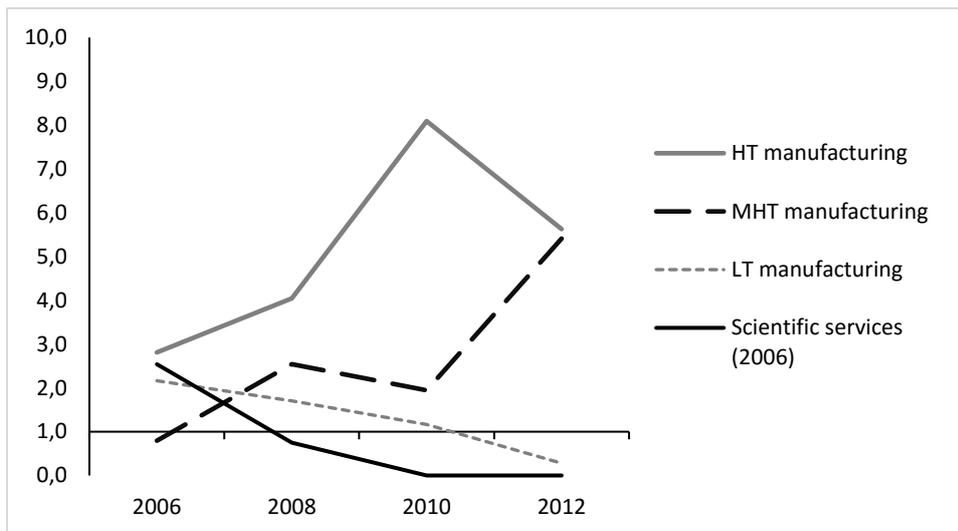
This increase in specialisation was driven by sharp decreases in the relative contribution of LT manufacturing and MLT manufacturing to local research system collaboration, and increases in the relative contributions of the HT and MHT manufacturing sectors (cf. Figure 16-8).

Figure 16-9 Sector contribution to local research system collaboration in Vestfold. The three largest at the beginning and end of the period



HT and MHT manufacturing firms also strengthened their commitment to local research system collaboration. At the same time, the commitment of the Scientific Services sector was reduced to zero, i.e. no local research system collaboration, while LT manufacturing only contributed 28 per cent of what would be expected from its size. All this adds to the evidence of evolution towards a specialised technology clusters more so than a RIS.

Figure 16-10 Sector commitment to local research system collaboration in Vestfold. The three most committed at the beginning and end of the period



16.5 The broad definition of RIS: Local inter-firm linkages

Figure 16-10 below demonstrates that highly concentrated local research system linkages are paralleled by high and increasing levels of sector concentration also in local inter-firm linkages. This adds to the evidence suggesting evolution towards a specialised innovation network more so than a networked regional innovation system based on variety.

Figure 16-11 Sector concentration of industrial collaboration in Vestfold

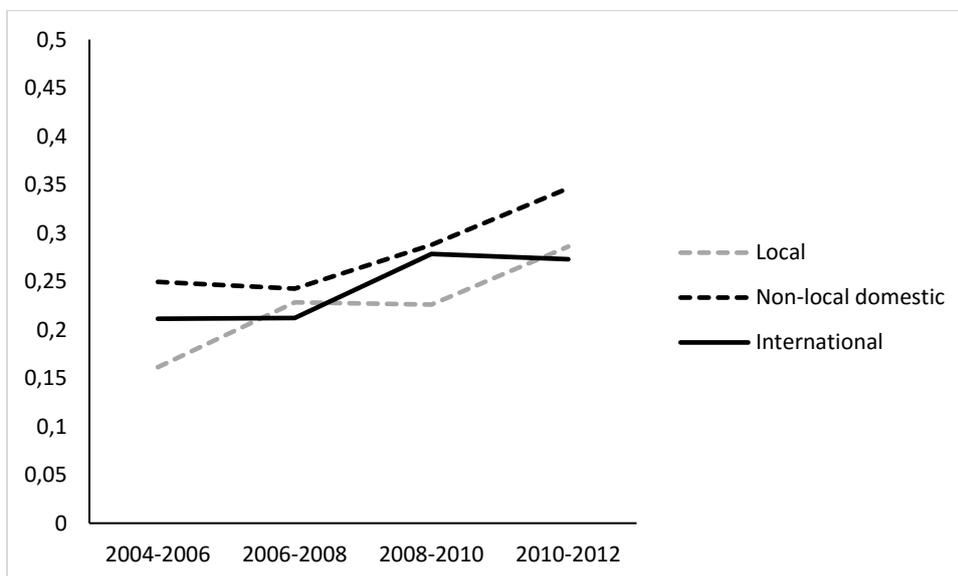
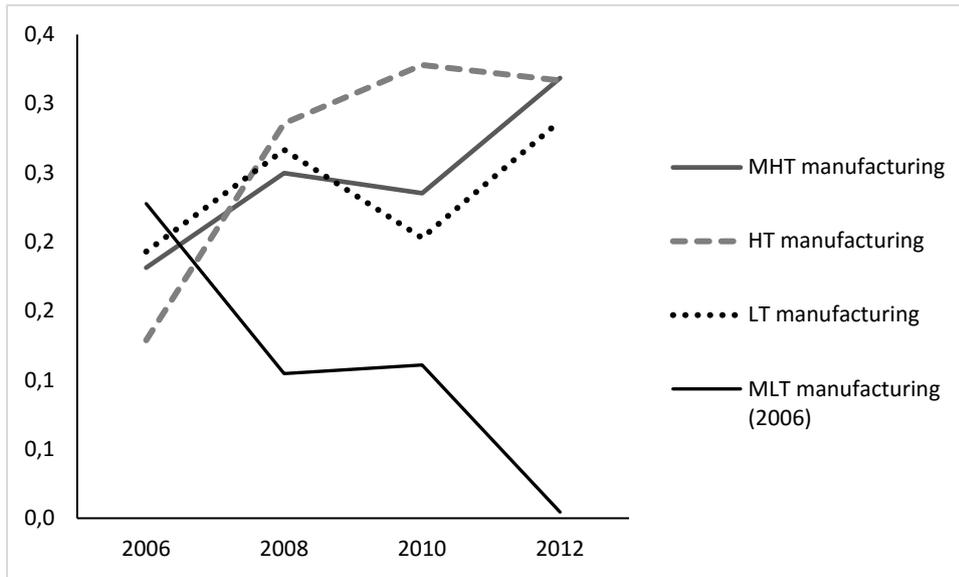


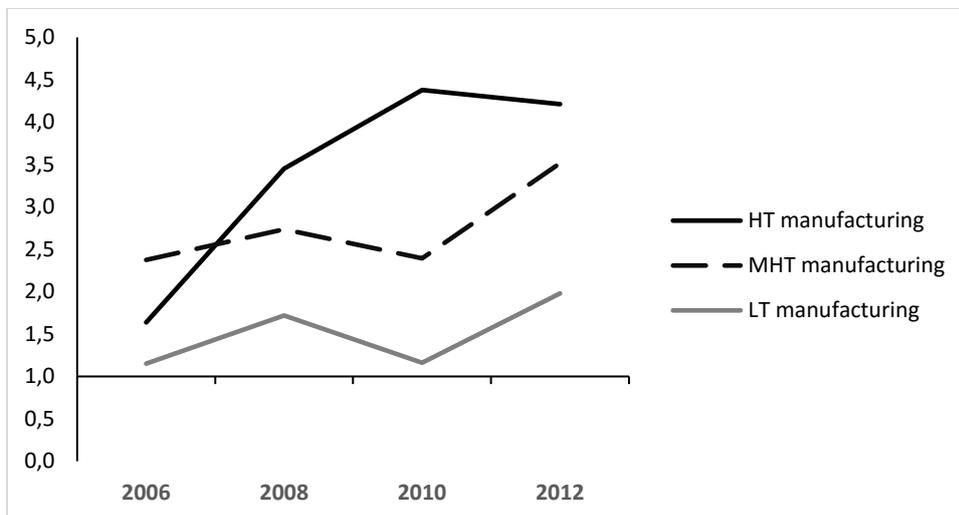
Figure 16-11 below illustrates how MLT manufacturing more or less withdrew from local inter-firm collaboration, while HT and MHT manufacturing increased their relative contributions substantially. At the end for the period, the two latter sectors for over 60 per cent of local inter-firm collaboration as defined herein.

Figure 16-12 Sector contribution to local industrial collaboration in Vestfold. *The three largest at the beginning and end of the period*



From Figure 16-12 below, it is evident that increasing contributions from the HT and MHT manufacturing sectors are mirrored in steadily increasing commitment levels. The LT manufacturing sector remained among the three most committed throughout the period, and contributed at the end of it almost twice as much to local inter-firm linkages than would be expected from its size.

Figure 16-13 Sector commitment to local industrial collaboration in Vestfold. *The three largest at the beginning and end of the period*



16.6 Summary

Vestfold exhibited relatively stable levels of innovation-active employment distributed on a broad range of industrial sectors. Still, the local networks of Vestfold are dominated by the technology-intensive manufacturing industries that are both the largest contributors to these networks, and the most committed to them. This strong discrepancy between the concentration of innovation-active employment and the concentration of employment in firms with a local industrial and research system collaboration suggests that the region possesses a more diverse foundation for RIS construction than is currently exploited and point towards the consolidation of a specialized regional innovation network within what is otherwise a region where the potential for this to evolve into a networked regional innovation system comprising a broader range of industries is strong. .

17 Østfold

17.1 Region overview

The relatively small VRI region of Østfold is specialised in manufacturing industries, and experienced only moderate employment growth. Employment in LT and MLT manufacturing declined substantially, while positive growth was exhibited by HT manufacturing, Technical & Scientific Services and Infrastructure, Environment & Energy.

Table 17-1 Location quotients & growth rates, Østfold. Sectors marked with grey are fully covered in the harmonized CIS sample

	Location quotients				Employment growth
	2006	2008	2010	2012	2006-2012
Primary	0,81	0,82	0,81	0,85	-17,82 %
Mining & Quarrying	0,60	0,54	0,67	0,59	14,41 %
Oil & Gas	0,00	0,00	0,01	0,01	(350 %)
HT manufacturing	1,23	1,29	1,42	1,48	4,63 %
MHT manufacturing	2,04	1,76	1,80	1,96	-6,79 %
MLT manufacturing	1,01	1,01	1,05	1,01	-12,01 %
LT manufacturing	1,89	1,98	1,93	1,68	-25,51 %
Infrastructure	0,79	0,83	0,78	0,84	17,74 %
Construction	1,23	1,21	1,21	1,24	13,21 %
Trade	1,09	1,10	1,10	1,10	-2,25 %
Transportation	0,76	0,77	0,78	0,79	-1,48 %
Horeca	0,74	0,81	0,77	0,79	8,45 %
ICTs	0,56	0,54	0,51	0,51	-0,85 %
Financial Services	0,67	0,68	0,72	0,73	9,40 %
Technical & Scientific services	0,70	0,67	0,71	0,70	18,62 %
Other services	0,93	0,97	0,95	0,90	4,71 %
Public administration	0,93	0,94	0,83	0,90	6,73 %
Education	0,93	0,93	0,95	0,98	9,11 %
Healthcare	1,07	1,09	1,13	1,14	12,66 %
Personal & Creative	0,84	0,82	0,83	0,86	11,37 %
Total	4,78 %	4,73 %	4,67 %	4,55 %	3,06 %

One distinct feature of Østfold is strong skill-relatedness between the MHT manufacturing sector and the LT manufacturing sector that in many other regions come out as related foremost to primary

17.2 Baseline innovation profile

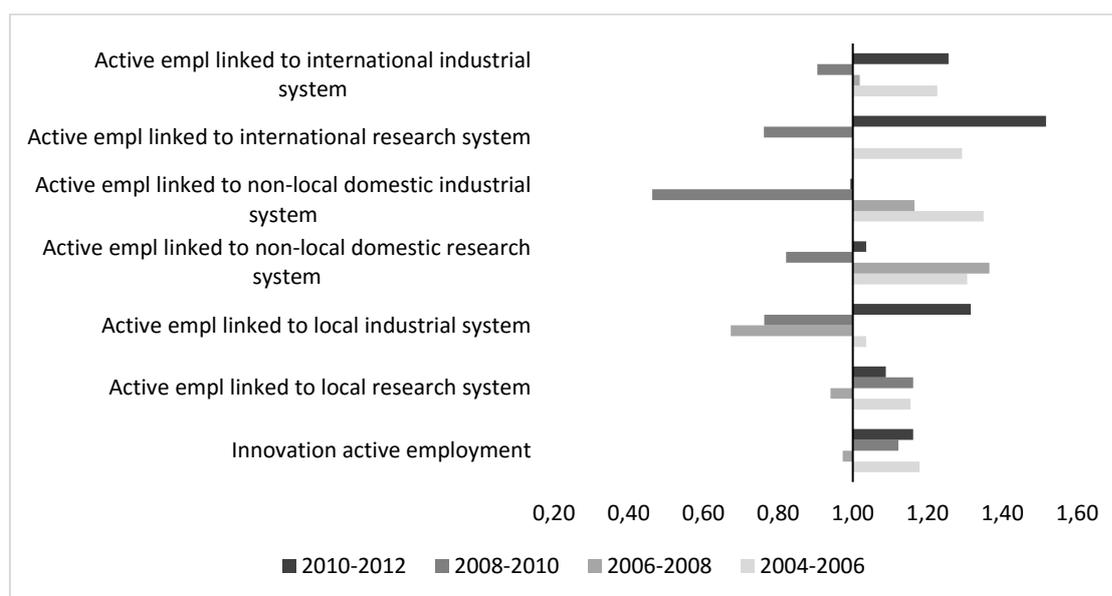
The first line in Table 17-2 below gives the number of establishments in Østfold that belong to enterprises sampled by the CIS. The second line gives the number of establishment that the sample represents, i.e. the population size estimated based on sampling weights provided by Statistics Norway.

Table 17-2 Number of establishment-level observations

	CIS2006	CIS2008	CIS2010	CIS2012
Unweighted (sample)	438	464	459	443
Weighted (population)	1043	1044	893	820

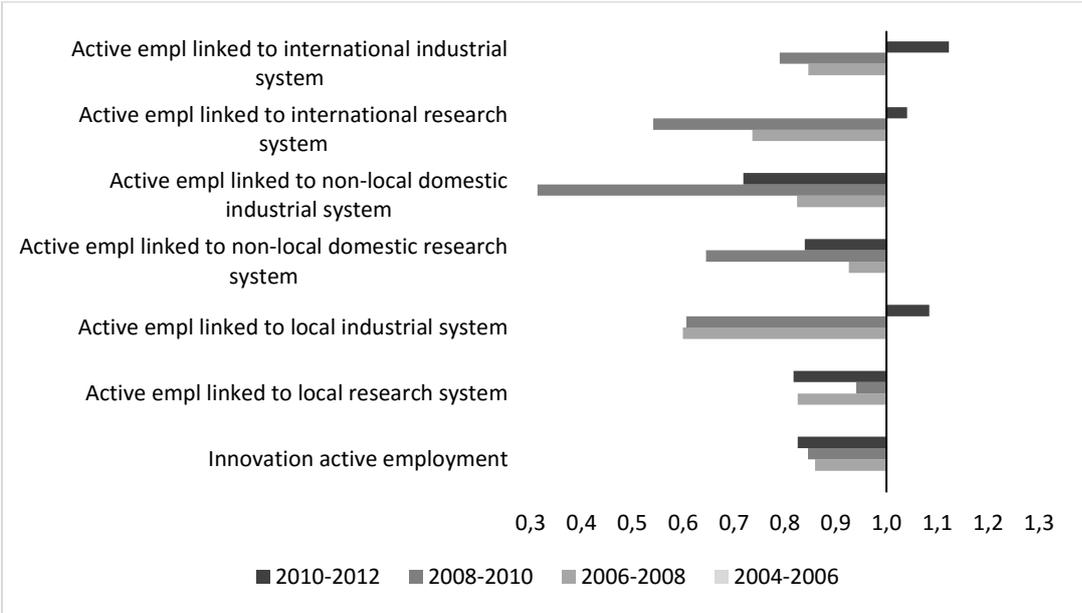
With the exception of 2006-2008, Østfold exhibited throughout the period innovation activity levels above the (declining) national average (Figure 17-3). Also with the exception of 2006-2008, local research system linkages remained above the national average. Other types of collaboration have fluctuated strongly around the national average, suggesting that linkages are dominated by large firms and their execution of specific innovation projects.

Figure 17-2 Innovation profile Østfold, relative to Norway = 1



Compared to the region itself, innovation activity levels decreased sharply from 2004-2006 to 2006-2008, to then decrease moderately through the subsequent waves of the CIS (Figure 17-3). Collaboration remained stable at levels below those exhibited at the beginning of the period, i.e. in 2004-2006, with the exception of slight increases during the last period in local and international inter-firm linkages, and in international research system linkages. As was the case in Vestfold, strong and parallel wave-to-wave fluctuations along several dimensions of collaboration indicate sensitivity of region statistics to the choices of specific firms in specific industries.

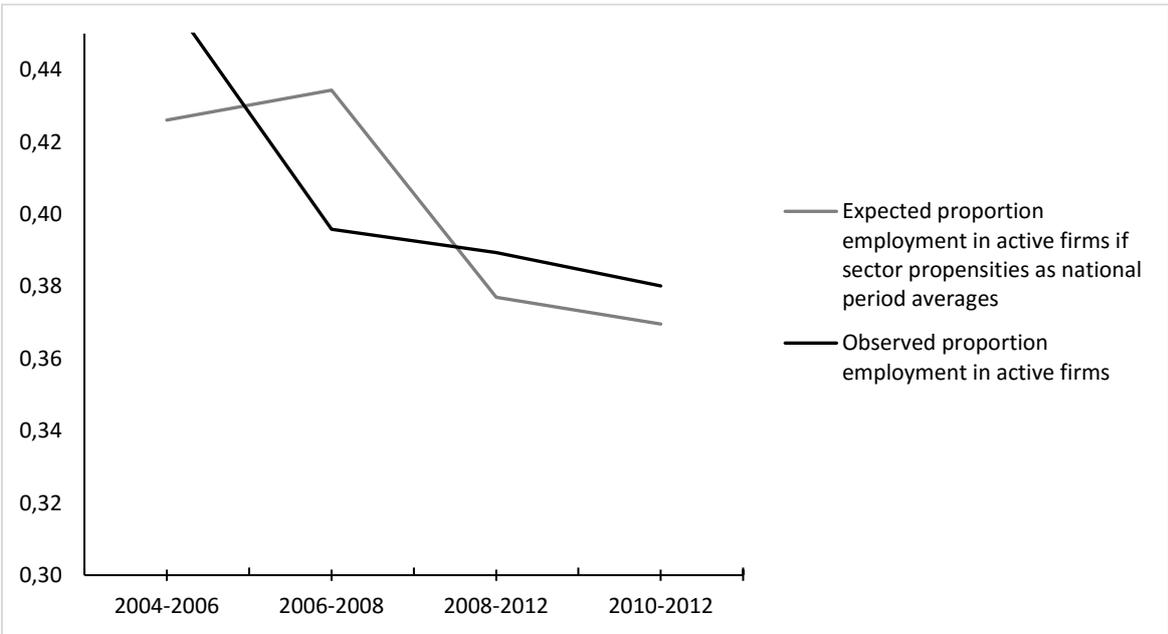
Figure 17-3 Innovation profile Østfold, relative to region in 2006 = 1



17.3 The micro-foundations for RIS

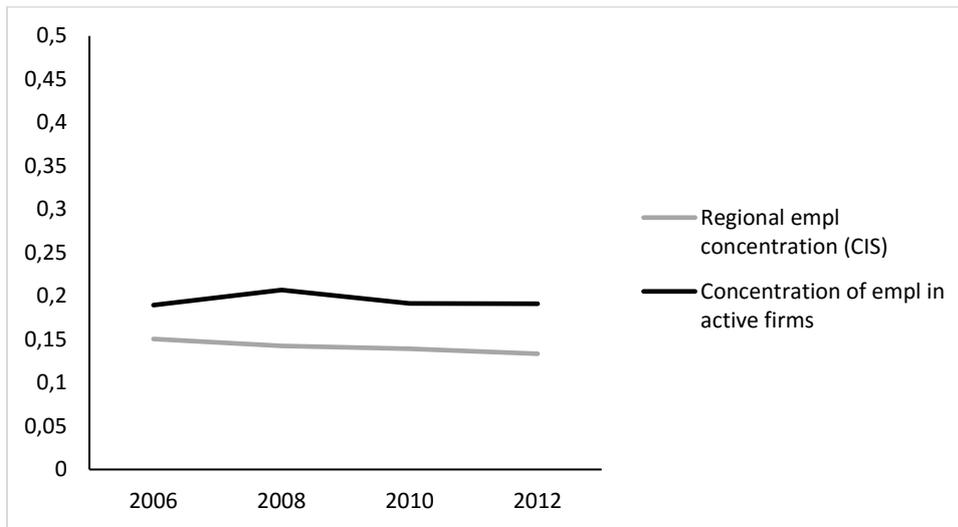
At the beginning of the period, observed innovation activity in Østfold was well above what would be expected, given the industrial composition of the region and the overall (downward) national trend. Levels declined to below what would be expected during the period 2006-2008, and then recovered. Thus, compared to the national sector-level trends for the sectors that dominate the employment base of Østfold, the micro-foundations for RIS construction emerge as strong.

Figure 17-4 Observed vs. expected innovation activity in Østfold



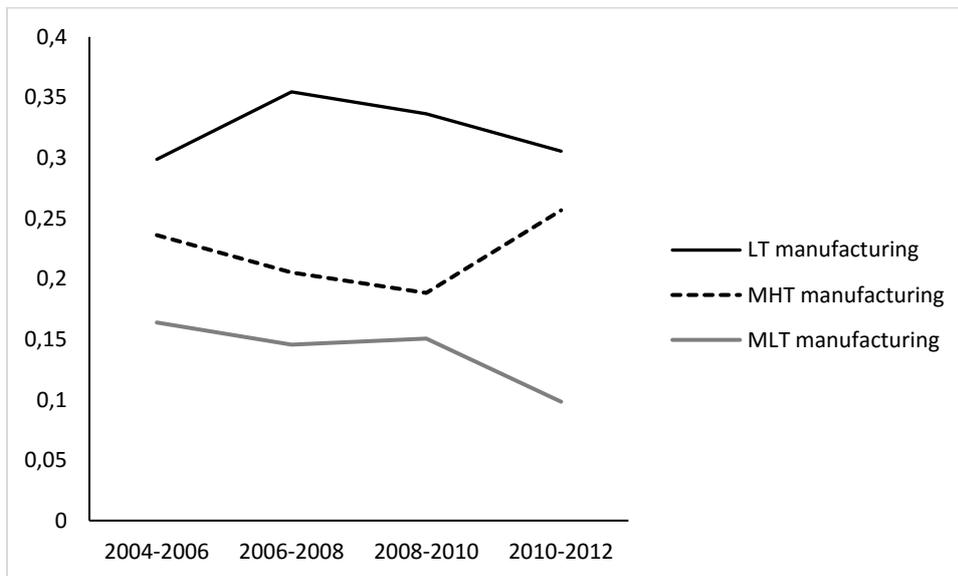
During the period 2006-2008 in which innovation activity levels were particularly low, the region exhibited a slight increase in concentration of this activity. Overall, the concentration of CIS employment and of active employment remained stable at levels that must be considered moderate given the size of the region.

Figure 17-5 Concentration of innovation active employment in Østfold



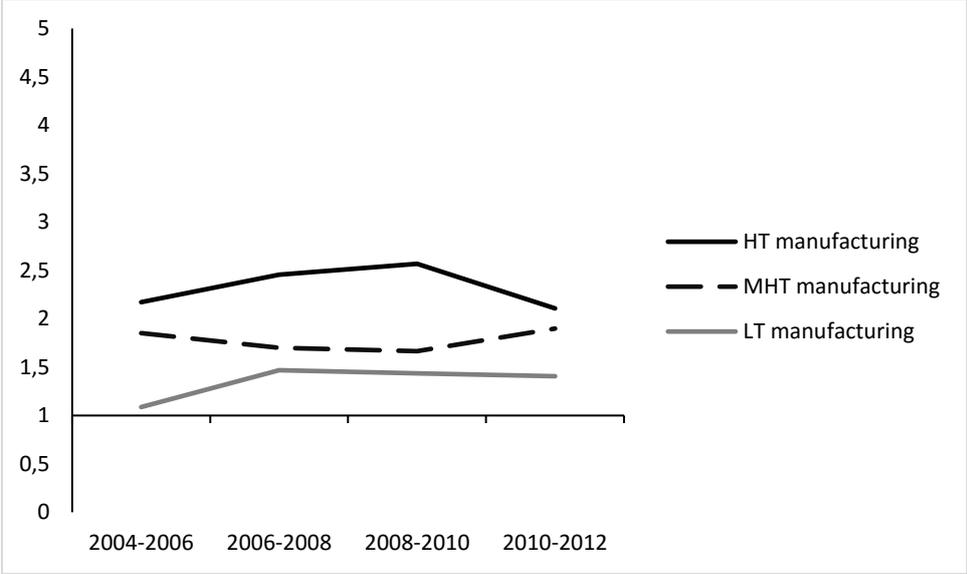
The contributions from the three largest sectors also remained relatively stable, with MHT manufacturing exhibiting a slight increase in its relative contribution and the LT and MLT manufacturing sectors exhibiting a parallel decrease (Figure 17-6). At the end of the period, these three sectors accounted for 67 per cent of innovation-active employment.

Figure 17-6 Sector contribution to innovation-active employment in Østfold. The three largest at the beginning and end of the period



Measured also in terms of commitment (Figure 17-6), the picture is one of stability in the dominance of the three large manufacturing industries.

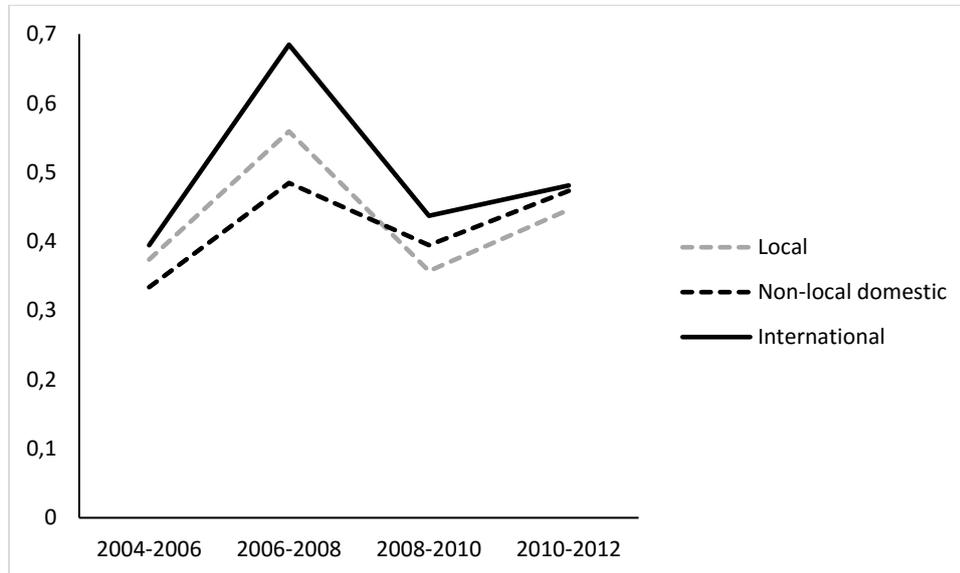
Figure 17-7 Sector commitment to innovation activity in Østfold. *The three most committed at the beginning and end of the period*



17.4 The narrow definition of RIS: Local research system linkages

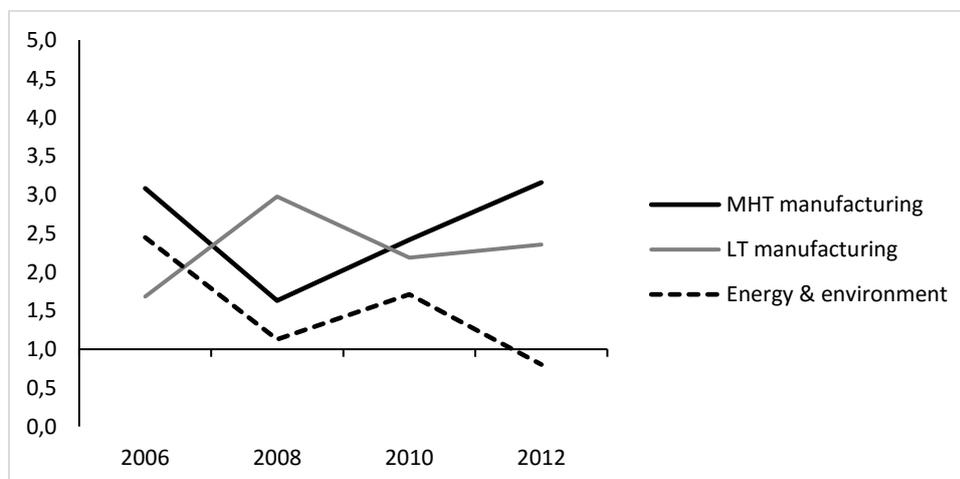
Compared to the moderate overall concentration of innovation-active employment, the concentration levels exhibited for research system collaboration in Østfold are exceptionally high. Fluctuations around this high average underscores the sensitivity of collaboration networks at all geographical scales to the entry and exit of specific actors and sectors.

Figure 17-8 Sector concentration of research system collaboration in Østfold



Data disclosures rules prohibit reporting of statistics on the contribution of the three largest sectors. Sufficient to say is that these accounted for an overwhelming proportion of employment in firms with a local research system linkage. Measured in terms of commitment, that of the LT and MHT manufacturing sectors remained stable through the period considered (cf. Figure 17-9). The second most committed sector at the beginning of the period, Infrastructure, Energy & Environment, steadily reduced its commitment, yet remained among the three most committed sectors even when exhibiting a level below 1. This further underscores the highly specialised nature of local research system linkages in Østfold.

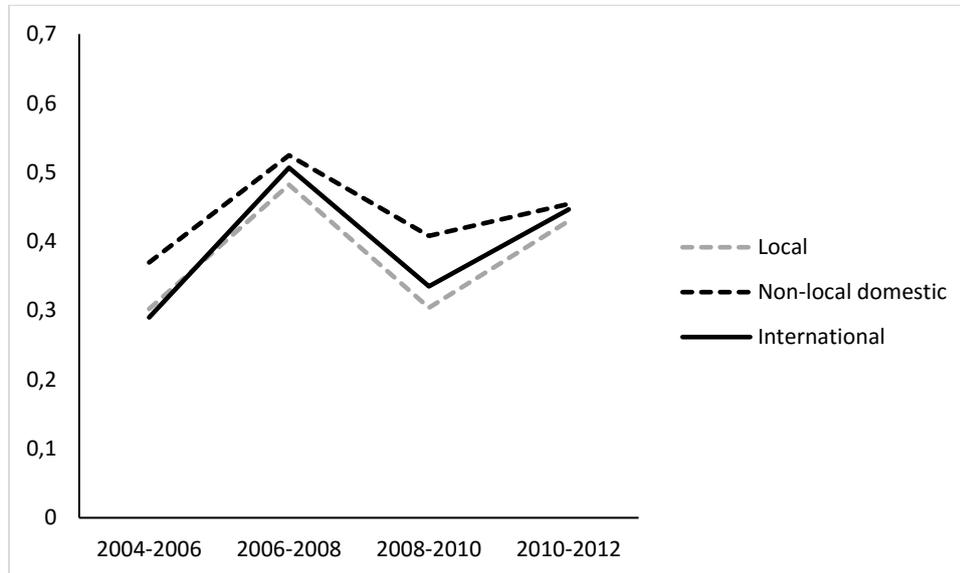
Figure 17-9 Sector commitment to local research system collaboration in Østfold. The three most committed at the beginning and end of the period



17.5 The broad definition of RIS: Local inter-firm linkages

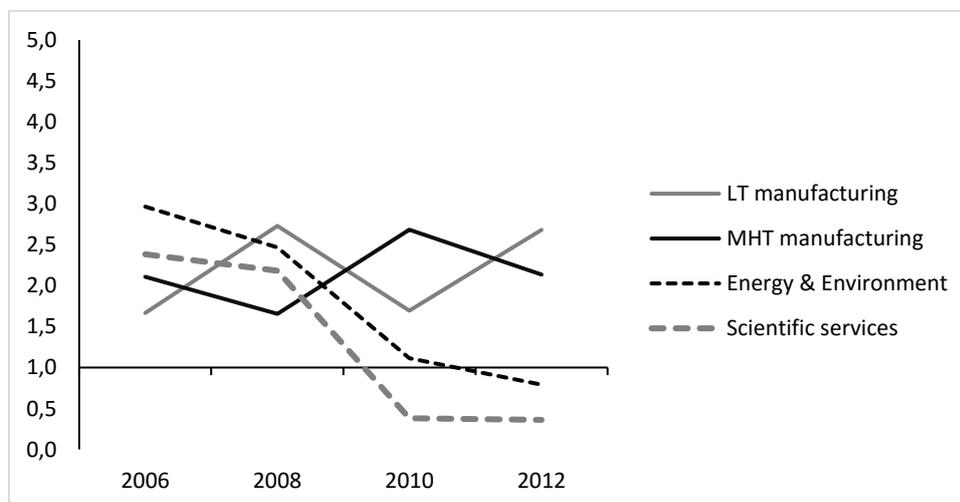
High levels of concentration and dominance of certain sectors is evident also in the inter-firm networks of Østfold. Figure 17-11 shows that concentration scores of these networks have fluctuated around high average levels. Beyond this, data disclosure rules prohibit reporting of statistics for the three largest contributors

Figure 17-10 Sector concentration of industrial collaboration in Østfold



Measured in terms of commitment, the Energy & Environment and Scientific Services contributed at the beginning of the period 3 and 2.4 times more to local industrial networks than would be expected from their size, ranking the two sectors as the most committed to such collaboration. Thus, they represent a certain degree of diversity in the local networks. However, both reduced their commitment steadily through the period, reaching levels of only 80 per cent (Energy & Environment) and 36 per cent (Scientific Services) of what would be expected from their overall contributions to innovation-active employment in the region. The commitment of LT and MHT manufacturing, by contrast, remained stable at high levels throughout the period.

Figure 17-11 Sector commitment to local industrial collaboration in Østfold. The three most committed at the beginning and end of the period



17.6 Summary

Through the period considered, the level of innovation activity in the VRI region of Østfold remained stable and strong, and the concentration of this activity was stable at a moderate level. Local collaboration, by contrast, exhibited high and fluctuating if not clearly increasing levels of industry concentration, i.e. specific industry dominance. Interpreted against the background of weakened non-local domestic networks and undetermined trends in international linkages, this point towards the consolidation of a specialised manufacturing cluster more so than the emergence of a RIS. Yet, it suggests also, as in Vestfold, that there is potential for evolution into a RIS if the broader innovation-active human resource base of the region is mobilized into constructing more diverse local research system and industrial networks.

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