Linking the bottom-up and top-down evolution of regional innovation systems to policy: Organizations, support structures and learning processes

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The literature is ambiguous about whether regional innovation systems (RIS) evolve bottom-up or top-down. This is reflected in RIS policies, which tend to focus on either development of the actor level, i.e. organizations in a RIS, or the system level, i.e. the support structure for innovation. Here, we analyzed a Norwegian RIS policy programme, the Programme for Regional R&D and Innovation (VRI), which aimed to combine both approaches. We found that VRI mainly developed the support structure for innovation and that learning outcomes from VRI involvement in organizations differed between the involved actor groups. This is particularly so for RIS development in regions inexperienced with support structure development prior to VRI involvement. Conversely, in regions with well-functioning support structures prior to VRI, focus was beneficially on stimulating learning at the actor level. We argue that future research should investigate mechanisms and interlinkages between the two levels and their regional particularities.

Keywords: RIS, actor, system, evolution, policy

Introduction

Nearly two decades of research on regional innovation systems (RIS) (Doloreux and Porto Gomez 2017) has had a distinct impact on (regional) innovation policies in several countries (Coenen et al. 2017; Tödtling and Trippl 2005; Mytelka and Smith 2002). A number of RIS initiatives have been implemented, where the rationale is that innovation results from knowledge sharing and learning in the interlinkages between differentiated actors within regional contexts (Fagerberg 2017; Asheim and Gertler 2005; Cooke, Gomez Uranga, and Etxebarria 1997). In these initiatives, policy is argued to play a specifically important role (Cooke 2007; Edquist 2001).

In this article, we investigate the role of policy in the evolution of RIS. In so doing, discussion arises concerning whether RIS evolve bottom-up or top-down; i.e.

whether policies should be targeted towards the organizations in RIS (the actor level) or the support structure (the system level). This theoretical discussion is reflected in previous studies, where it was found that policies intended to stimulate RIS development tended to address one of the two levels (Nauwelaers and Wintjes 2002; Jakobsen, Byrkjeland et al. 2012; Pugh 2016). Furthermore, the discussion is also relevant to recent conceptual discussions on the balance between actor- and system-level support in regional innovation policies (Isaksen and Jakobsen 2016), regional industry renewal (Isaksen et al. 2016) and more broadly, regional development (Zukauskaite et al. 2017).

We follow Asheim et al. (2015: 274) in defining a RIS as 'the institutional and organizational infrastructure interacting and supporting innovation within the production system of a region'. We build on a narrow understanding of RIS (see Asheim et al. 2015: 274–275), i.e. RIS as regional partnerships encompassing involved actors, as we believe this is particularly valid when discussing how RIS policies can proactively target and encourage interaction and collaboration between firms and R&D institutions in a region. Furthermore, we consider the dichotomous interplay between the actor and system levels as central for RIS evolution. Hence, linking these discussions to RIS policies, we emphasize the importance of stimulating learning in both organizations and the support structure for innovation (cf. Coenen et al. 2017; Moodysson and Zukauskaite 2014). However, although this may be theoretically sound, we show the need to deepen and differentiate this theoretical assumption. We substantiate our argument through an empirical study of a Norwegian RIS policy programme, the Programme for Regional R&D and Innovation (VRI). VRI was a public innovation programme that was initiated at the national level and was operated by the Research Council of Norway (RCN) (Jakobsen, Byrkjeland et al. 2012). The

programme ran for 10 years, from 2007 to 2016. The aim of the programme was to stimulate innovation in Norwegian regions by increasing co-operation between research and development (R&D) organizations and industry. Interestingly, VRI was presented as 'unique in that it combines direct firm-level activities, both in single firms and networks, innovation and organizational research, and that it focuses on regional collaboration' (The Research Council of Norway 2009, 1; our translation and italics). An explicit aim of the programme was to stimulate learning processes at both actor and system levels, where VRI resembled a narrow approach to RIS. We found that learning outcomes from involvement in VRI are overall highest in the regional partnerships developed through VRI, i.e. the support structure for innovation. Moreover, we found that past experiences with policy tools and pre-existing practices of the involved actors matter when explaining how VRI has contributed to development of RIS in Norwegian regions. Differences between the regional initiatives are, *inter alia*, the result of regional policy histories (i.e. experience with similar policy tools) and differing characteristics of regional firms and R&D organizations (i.e. organizational practices).

Thus, this paper addresses the following research questions.

- What has been the role of VRI in developing the actor and system levels in RIS?
- What can RIS policies and theories learn from the VRI programme?

To answer these questions, we develop an analytical framework that is sensitive to the dynamic between bottom-up and top-down evolution of RIS. We propose that policies for RIS evolution should be sensitive to both the organizational and institutional characteristics of a region (Zukauskaite et al. 2017; Isaksen et al. 2016). Consequently, we contribute to the theoretical and empirical discussion on the role of policy in RIS evolution, and, more specifically, to how policies should—as RIS develop as the result of both bottom-up and top-down processes—be sensitive towards both the

actor and system levels. However, regions differ in their policy focuses. Future research should investigate the mechanisms and interlinkages between the two levels. In addition, we illustrate how RIS policies can contribute to different learning outcomes both within and between the two analytical levels, which should also be considered.

Theoretical background

Defining RIS

A central rationale in the RIS approach is that formal and informal institutions (Asheim, Coenen, and Moodysson 2015; Asheim and Gertler 2005; Cooke, Gomez Uranga, and Etxebarria 1997) set the framework conditions for knowledge exchange, interaction and learning among and between regional actors. However, institutional conditions are not the only concern for RIS theory. RIS are also concerned with the functionality of organizational practices, i.e. how actors within a region interact and collaborate. In other words, RIS have been considered as a set of relations between interacting private firms, public authorities and R&D organizations (Doloreux 2002), while also having been classified according to its institutional thickness (Amin and Thrift 1995), i.e. its regional setting characteristics (Isaksen and Trippl 2016; Nilsson and Moodysson 2014). Moreover, it is common to differentiate between a narrow and a broad approach to RIS (Asheim and Gertler 2005). The broad approach is concerned with all aspects influencing the production system of a region (Nilsson and Moodysson 2014; Miörner and Trippl 2017). However, the narrow approach emphasizes practical, ad-hoc interaction between R&D organizations, knowledge-intensive firms, technology transfer organizations and other supporting bodies. This implies that a narrow approach focuses on the involvement of some, but not all, actors in a region and where an aim is to set up meeting places, encourage development of relations, and stimulate joint action and

shared understandings (Anonymous and Anonymous 2017). A common way to operationalize this approach is to juxtapose it with regional partnerships. The idea behind regional partnerships is that actors in triple helices nurture development of a culture of interaction, knowledge sharing and learning, and that the coming together of actors from different parts of the triple helix benefits regional interests (Etzkowitz and Leydesdorff 2000; Sørensen and Torfing 2007). This represents a traditional approach to what a RIS is and focuses on collaboration between groups of regional actors from different spheres (such as business, R&D and policy) (Asheim et al. 2015). We believe that a narrow approach is particularly valid when the aim is to investigate the role of policy in stimulating collaborations between firms and R&D organizations in the evolution of RIS (Anonymous and Anonymous, 2017). That is not to say that policy does not play a role in supporting broad RIS developments; however, tracing such attempts are necessarily difficult because it involves a high degree of complexity and uncertainty (Flanagan and Uyarra 2016). In addition, as noted by Anonymous and Anonymous (2017: 2), 'if regions lack the sufficient infrastructure supporting interaction between organizations, firms, and public agencies, that is, if a region is not able to stimulate linkages between the actors, policy implementation is particularly difficult'. In other words, we argue that the broad and narrow approaches are interlinked where the latter also can play an important role in embedding and developing broad regional innovation policies.

Hence, we propose that regional partnerships can take a role in stimulating practical interactions between regional actors, especially when the aim is to link firms and R&D organizations. From this perspective, RIS evolution is about stimulating interaction among participating regional actors, not necessarily all regional actors. Moreover, a narrow approach to RIS does not eliminate the importance of the broad

approach. Rather, the narrow approach can be important for implementation of broader regional innovation policies. Consequently, development of regional partnerships in this article corresponds to the system level of RIS theorizing.

RIS from an evolutionary perspective

In other words, a central aim of a RIS is to stimulate knowledge sharing and learning within regional contexts (Cooke 2008, 2004), where recent contributions have emphasized the need to also include the demand-side, i.e. industry characteristics, when approaching RIS (Asheim et al. 2016). Regions necessarily have different industry characteristics and challenges/opportunities (Foray 2015). However, for analytical purposes, such differences need to be categorized. For example, this can be done by classifying a region and its innovation system according to firms' modes of innovation, knowledge bases or value chains. Another approach is to link organizational practices to institutional settings (Isaksen and Trippl 2016). Isaksen and Trippl (2016:) separated RIS into 'organizationally thick and diversified,' 'organizationally thick and specialized' and 'organizationally thin', and argued that each of the ideal types require different policy measures. In other words, a RIS should be understood not just by looking at its 'institutional thickness', but also by looking at its interlinked organizational practices. Furthermore, this argument is linked to evolutionary theorizing, which holds that existing practices of firms and other regional organizations (and institutions) influence future development paths (Martin and Sunley 2006), and that these strongholds should be further strengthened through targeted policies (cf. the European Union's smart specialization strategies). The evolutionary rationale is that continuous upgrading and renewal is key for future economic growth, which calls for a specific focus on knowledge development and learning, and, not least, the dynamic

mechanisms underpinning regional industrial change. However, this literature has acknowledged the need to better incorporate the actor level when investigating such mechanisms for change (Simmie 2012; Sydow, Schreyögg, and Koch 2009; Brunninge and Melander 2016; Holmen and Fosse 2017; Karnøe and Garud 2012; Pike et al. 2016) something that also has been taken into account in RIS research (Asheim et al. 2015, Nilsson and Moodysson 2014). Thus, the actor level should also be focused on in RIS investigations.

Hence, according to evolutionary theory, learning processes are considered focal to RIS evolution (Cooke 2007, 2004), particularly in avoiding negative path dependency and lock-in (Isaksen et al. 2016). Consequently, recent research has been particularly occupied with attempting to understand both how actors learn and share knowledge, but also how constellations of actors from different spheres, i.e. triple helices, facilitate learning and knowledge sharing (Tjong Tjin Tai and Davids 2016, Cooke, Clifton, and Oleaga 2005; Heidenreich 2005; Cooke 2004). This implies that both the actor (organizations in a RIS) and system (the support structure) levels can learn, and based on this learning, they contribute to regional development and innovation through upgrading and renewal of existing practices. For instance, this could mean that organizations learn how to utilize regional resources (e.g. access the regional knowledge pool, R&D organizations and other firms, or the support structure for innovation) through regional interaction. Similarly, the support structure can learn how best to utilize and combine regional resources through facilitation initiatives and encouraging—and developing—networks between relevant and related actors (Fosse and Normann 2015). Hence, the question is which learning processes should be stimulated to contribute to the evolution of RIS related to discussions in the literature on whether RIS evolve bottom-up (i.e. as the result of development of organizations in a

region) or top-down (i.e. as the result of development of the support structure for innovation).

RIS evolution policies

The jury is still out regarding whether RIS evolution is the result of bottom-up or top-down processes (Uyarra 2010). For instance, it has been argued that the RIS literature should acknowledge not only system structures, but also the role of actors (i.e. organizations) in RIS development (Nilsson and Moodysson 2014; Miörner and Trippl 2017). In this sense, Moodysson and Zukauskaite (2014) argued that there is a danger of 'overstimulating' network-building initiatives, which may 'alienate' participating actors. Therefore, they argued that the level of ambition in developing system structures can hamper actors' motivations and roles in shaping RIS, which highlights the need to strike a balance between long-term development of support infrastructures and development of short-term projects where firms and organizations are the driving forces. The implication of this for RIS policies is that they should not focus solely on stimulating partnership formation and support structures for innovation. Inclusion of participating actors (i.e. firms, R&D institutions and public bodies) should acknowledge that regional particularities are the sum of these actors' challenges and specificities and that these should be addressed through properly embedded projects (Nilsson and Moodysson 2014). In a similar vein, Asheim et al. (2015, 279) argued that the RIS approach is conceptually 'somewhat blunt as a tool for understanding the organization of innovation from the perspective of the actors (i.e. organizations and individuals)'. Thus, recent contributions have argued that addressing only one of the two levels is insufficient if the aim is to contribute to long-term regional economic development (Isaksen et al. 2016, Zukauskaite et al. 2017). This gives RIS policies a particularly

important role in stimulating learning processes on both the actor and system levels (Table 1). However, studies of the interplay between these levels are lacking in the academic literature (Boschma et al. 2017). Moreover, it has been shown that policies for regional development tend to follow a path-dependence logic where new initiatives often follow the logic of preceding policy instruments (Jakobsen, Byrkjeland, et al. 2012; Flanagan and Uyarra 2016). In addition, the implementation of theoretical ideas into policy practice has been shown to be challenging (Flanagan and Uyarra 2016; Uyarra et al. 2017). Implementation may be even more difficult when the concepts and theories are, as in the case of the RIS concept, academically fuzzy or contested (Njøs et al. 2016; Uyarra and Flanagan 2010). In other words, policy development and implementation based on the RIS concept face several challenges related to inclusion of the relevant actors, roles and rationales. This is partly the background for the axiomatic understanding that one size does not fit all in terms of regional innovation policies (Tödtling and Trippl 2005), where regional autonomy in terms of both policy development and implementation has gained increasing focus throughout Europe (Prange 2008; Pugh 2016). However, whether such approaches should be aimed towards the actors in a RIS or the support structure is debatable, not least when it comes to policy-making and implementation.

[Insert Table 1 about here]

The next section presents the Norwegian VRI policy programme, which aimed to strike a balance between stimulating learning in developing RIS at actor and system levels. This approach was explicitly recognized by the RCN, who operated the programme.

> *To develop the regional innovation systems, the Research Council works through VRI on several levels. Firstly,* broad regional partnerships *identify and carry out development strategies of the regional innovation systems through […] collaboration projects. This way, the regions develop their ability to [carry out] collaboration and innovation processes. Secondly,* the actors in the collaboration projects *work proactively with firms and networks of firms, in order to link these to research institutions so that relations are generated and strengthened* (The Research Council of Norway 2013, 7; our italics).

In other words, the VRI programme represents a rare attempt at developing RIS through targeting development of both the actor and system levels, while also sustaining financial support over a long period, 10 years in this case. In our analysis, we approached the theoretical concepts of actor and system levels as organizations and support structures for innovation, respectively. Furthermore, we deepened these concepts in our investigation of VRI, which was separated between organizations (in the case of VRI this includes firms, R&D organizations and county administrations) and regional partnerships (Table 2).

[Insert Table 2 about here]

Empirical investigation

The VRI programme

The VRI programme (Programme for Regional R&D and Innovation) was an initiative

launched by the RCN with the aim of developing RIS in Norwegian regions. The programme operated between 2007 and 2016, and ended after three programme periods (VRI 1, 2007–2010; VRI 2, 2011–2013; and VRI 3, 2014–2016). The programme granted funding to two different types of projects: i.e. collaboration and innovation research projects. In VRI 1 and 2, all regions were granted both collaboration and research projects, and they were required to co-operate to be granted funding. In VRI 3, research projects were organized as thematic projects that were granted funding on the merits of the application independent of region.

We focus on the regional collaboration projects. There were 15 regional collaboration projects in each of the three programme periods. All Norwegian counties (19) were involved in one project, while two counties co-operated in four of the collaboration projects. The VRI programme was initiated from the national level, where the RCN was the operator and owner of the programme. The aim of the programme was to extend previous regional policy programmes into a new initiative (Jakobsen, Byrkjeland et al. 2012), which aimed to strengthen research-based innovation in and among Norwegian firms through interactions between firms and R&D organizations. The modus operandi for reaching this goal was through development of RIS and through stimulating learning processes in organizations targeted by VRI support (the actor level) and regional partnerships (the system level). Importantly, regional VRI initiatives were required to form regional partnerships where key actors from industry, research and public bodies were represented. The idea was to facilitate development of support structures for innovation spanning individual linkages between firms and R&D organizations, which would provide learning among participating actors, changing their practices and how they work with innovation (i.e. through introducing the systemic approach to innovation). Moreover, the regions were expected to differentiate between

policy measures according to regional-specific challenges and the regional approaches had to be embedded in the partnerships.

In their applications, the regional initiatives defined main goals and target areas, and the type of tools that would be used to achieve these goals. Some of these tools were linked to stimulating practical interactions between involved actors (e.g. the competence brokering tool and diverse tools for mobilizing knowledge sharing between differentiated partners), but also towards development of social capital and regional partnerships (e.g. dialogue conferences where involved actors were introduced to system-oriented policy tools). Moreover, it is important to note that VRI primarily contributed to networking and mobilizing for research. That is, the VRI programme did not fund research activities but instead linked relevant activities to other policy tools (e.g. the Regional Research Funds and other public innovation tools). Funding for the regional collaboration projects ranged from €200,000 to €900,000 over a three-year period, with the RCN requirement that at least 50% of each project was financed regionally through in-kind or cash contributions from county administrations or actors in the partnerships. Necessarily, the relatively small financial size of the projects also set limits as to what could be achieved by the regional VRI projects.

Three main actor groups were involved in VRI: firms/industry facilitators representing the business side; R&D organizations; and, although several public bodies were involved, the most important participants from the public sector were the county administrations through their role as project managers and co-ordinators of VRI activities. In some regions, firms and/or industry facilitators were part of the consortia (i.e. partnerships) applying for collaboration projects in VRI. In our analysis, however, we are concerned with exploring the extent to which firms receiving policy support

from VRI experienced learning outcomes leading to changes in how they work with innovation.

Methods and data collection

To investigate the role of VRI in balancing stimulation of learning at the actor and system levels, we analyzed all collaboration projects. The investigation consisted of a qualitative analysis of all accepted applications (45) for collaboration projects during the three programme periods (15 regions × three VRI periods), 25 semi-structured interviews with central personnel in nearly all regional VRI initiatives, as well as secondary data.

Investigation of each VRI region throughout the three periods means that we gained deep insight into the different regional projects and how they changed both individually and compared with other regions. However, as the topic here is to investigate interplays between the actor and system levels in RIS evolution, the analyses were particularly focused on interviews that discussed learning outcomes from VRI (for involved organizations and for the partnerships). The 25 interviews were conducted with representatives from different regional projects after completion of the document analysis. Participants were selected in consultation with VRI 3 project leaders. We aimed to interview two key participants (one from an R&D organization and one from a county administration) from each region who knew the history and background of all three VRI projects in the region. In some regions, the project leader in VRI 3 served as a participant. However, all participants shared in common that they were highly familiar with the regional partnerships and VRI project(s) in some capacity or other. Interviews were conducted by telephone and lasted between 44 and 124 minutes. Two interviews were conducted in eight regions, one interview in five regions and three interviews in

one region. The interview guide was informed by the analysis of the regional VRI applications. In analyzing the VRI applications, we coded the 45 documents according to categories (i.e. nodes) that we developed for the purpose. In developing a preliminary set of nodes, we combined, *inter alia*, the theoretical perspective of this article with our insights into the VRI programme. However, as our reading of the applications progressed, we had to revise the nodes continuously because we found that our preliminary categories had to be deepened. Thus, after some rounds of revising the nodes—through comparing theories and empirical material—we developed a final set of nodes used to categorize all 45 applications. The final set of nodes were, *inter alia*: 'organization', 'about the regional innovation system', 'continuity [i.e. linking VRI to previous policy programmes and regional responses to these programmes]', different nodes on tools employed in the VRI projects, and a set of nodes linked to learning outcomes, i.e. for 'firms', 'R&D organizations' and 'public agencies'. In addition, we coded text on 'balance between national control and regional autonomy', and 'negative' and 'positive' experiences with VRI. Based on this coding, which was conducted using NVivo software, we looked for qualitative similarities and differences between regions and project periods. This led to development of an interview guide, covering the following themes: project profile, key strategies, organization, (perceived) regional degree of autonomy/scope of action in project development, tools applied in RIS development, co-ordination with other policy instruments and instruments, and experience and changes from VRI 1 to VRI 3.

Both the document analysis and the transcribed interviews were coded and categorized using NVivo software with the same set of nodes for both data sources, which enabled us to compare findings across regions and VRI periods. In addition, we also accessed secondary data such as reports, publications and evaluations, and studied

national VRI policy documents (such as annual reports, programme plans, handbooks, web pages). Secondary sources were important for analyzing learning outcomes and changes, especially in firms (Garmann Johnsen 2010; Båtevik and Yttredal 2010; Jakobsen, Byrkjeland, et al. 2012; Oxford Research 2012) because this actor group was not directly captured by our data collection. Thus, this is one of the limitations of our analysis; i.e. we do not have primary data from the firms involved in VRI. We based our analysis on interviews with participants from the R&D sector and county administrations. Naturally, these actors do not have the full picture of their firms' learning outcomes from VRI participation. This limitation can be overcome to some extent by data from external evaluations (i.e. secondary sources). Additionally, participants were highly knowledgeable about the regional projects and how these have evolved and necessarily also had insights into what has worked and what has not worked in their VRI projects (such as to what extent firms participated in the projects and the feedback they gave). We experienced the participants as being reflective and open about representing several aspects of their VRI projects, which was based on several years of experience, and the involvement of firms. Another limitation is that our data material is extensive rather than intensive. We performed few interviews in each region; therefore, the danger of participants giving flattering self-narratives exists. However, this study does not investigate the regional implementation of VRI (see Anonymous and Anonymous 2017), but rather synthesizes experiences across regions and program periods, and links this to RIS evolution and the role of policy.

The next sections link our analysis of the VRI programme to the theoretical framework presented above, where we first explored the role of VRI in stimulating learning in organizations and the support structures for innovation in Norwegian regions, before discussing how these findings can inform RIS theories and policies.

Findings

Actor level

One of the aims of the VRI programme was to stimulate learning at the actor level. Thus, three actor groups were central to the study: i.e. firms, R&D organizations and county administrations. Through introducing the interactive approach of innovation to these actor groups, the VRI programme aimed to stimulate their participation in the RIS and also their knowledge of—and linkages to—other public innovation tools, particularly the ones offered by the RCN. In many respects, the VRI programme was intended as a tool to fill the gap between other policy tools for innovation, R&D and regional development; therefore, it should be considered an important part of the policy mix in that it was intended to bridge and link together other policy instruments. This also meant that, through their VRI participation, organizations (firms, R&D organizations and public bodies) were introduced to relevant policy tools and thereby became familiar with the opportunities represented by interaction with other parts of the triple helix and involvement with policy tools and programmes. Thus, the idea was that, through the utilization of different tools offered by the programme, the introduction of VRI to participating organizations would lead to learning outcomes based on experiences with R&D involvement (for firms) and R&D–industry relations (for R&D organizations), which would in turn change how the organizations work with innovation by using the available regional resources. However, our investigation found that the extent to which the involved actors changed how they work with innovation and their learning outcomes differed between the three actor groups.

Firms

Previous evaluations found that the VRI programme contributed to increased

engagement in R&D activity among the firms involved. These activities were primarily linked to improving the firms' networks, gaining experience with R&D and the development of firm competences (Jakobsen and Døving 2006; Jakobsen, Fosse et al. 2012; Jakobsen and Stensheim 2007; Jøranli 2009). This concurs with findings from our data collection, where our participants pointed out that participating firms were generally satisfied with the VRI programme. Their responses were primarily linked to practical outcomes from the project they were involved in (typically, help in solving a specific problem using R&D), but they also highlight that participating firms increased their knowledge of the support structure and the opportunities therein. Thus, for many firms,

> *VRI has been very important for how [they] see the beneficiaries of collaboration with other firms. And that they can achieve more and bigger effects on their development projects if they conduct them together with other partners. That is, working with innovation through networks.*
> (Representative from R&D organization)

Furthermore, participation in VRI changed firms' opinions of research. Our participants pointed out that one of the outcomes was to make research less frightening for the firms. This means that through participation in small projects or as recipients of support from a VRI tool, the firms were given an 'eye-opener' into what research could contribute with in development and innovation. As one participant commented:

> *I recently went to a seminar and I was baffled by the fact that there was a common agreement among the firms that it was important to strengthen their research activities and their linkages to the universities and*

university colleges. That was a completely new experience for me. (Representative from R&D organization)

However, as noted above, one aim of RIS policies is also to stimulate learning beyond the scope of introduction of a policy instrument; i.e. they should also change how involved actors work with innovation. When discussing the learning outcomes for participating firms, our informants were ambiguous as to whether VRI had led to changes in organizational practices. In general, they argued that VRI had stimulated establishment of contacts between firms and R&D organizations and that such connections occasionally resulted in long-term co-operation, i.e. beyond the support of the VRI programme.

I think several of the firms have learned quite a lot. We do see, over the years, that some of the firms move on to apply for financing in other programmes. We take that as an indication that they have learned something positive regarding the use of external funding in development projects. (Representative from R&D organization)

As the regional VRI initiatives were required to link their projects to specific target areas (e.g. specific industries, industry clusters), the VRI projects necessarily targeted different types of industries and firms. This is important for deepening our findings. As different industries are characterized by different modes of innovation, R&D experience and dynamics (see Section 'RIS from an evolutionary perspective'), firms involved in VRI also differ. Consequently, it proved harder for some regions or projects to contribute to changes in organizational practices, given that the areas the efforts were targeted towards were represented by firms inexperienced in innovation and R&D. One participant explained:

> *In some industries, like the tourism industry, they do not necessarily use research in the same way as they do in [the missile industry]. Those two industries are just so very different. If you work with missile technology, you need a PhD. I don't think you'll find a single person in the tourism industry with a PhD […] So, targeting the tourism industry, which is not even interested in paying for research, and making them get to grips with what this is about—teaching them how to commission research—that's a massive task. And it takes time.* (Representative from R&D organization)

Thus, in regions that focus on industries where involved firms were experienced with R&D and innovation work, learning outcomes appear to be higher than in regions where target areas/industries were less familiar with R&D and R&D–industry linkages.

Thus, in general, the VRI programme has to a moderate degree contributed to stimulation of learning processes in firms. Firms are given an eye-opener into what research can contribute; they are introduced to the interactive mode of innovation and relevant policy tools, and, in some instances, the firms also internalized learning about how to utilize these resources beyond the assistance of VRI. However, regional differences are prominent and are related to the extent of experiences of *a priori* VRI involvement and which target areas (i.e. industries) the VRI projects addressed.

R&D organizations

For the R&D organizations, our participants emphasized that participation in VRI was often linked to motivated individuals, which made it challenging to internalize and institutionalize learning from VRI activity in the R&D organizations. This was particularly the case with VRI 1 and 2. One participant noted:

> *It is reasonable to say that, in retrospect, we did something clever. We went on a study tour to [a research institution] and met with the relevant research groups. We became informed about what they were doing and said something about what we did. In other words, we dropped the principle of linkages on an organizational level and instead opened up the opportunity to meet and get to know relevant scientists.* (County Administration Representative)

Exemplifying the importance of relatively low-threshold activities such as facilitating meetings and meeting places between actor groups has proved important in VRI, especially when linking firms and R&D organizations. Participants argued that R&D organizations typically became more aware of co-operation with regional industry during the VRI programme and of the benefits of such collaborations. In other words, in VRI 3, R&D organizations appeared to be more involved in VRI activity and more integrated in collaboration activities. In the same way as the involved firms, the R&D organizations were also introduced to public policy tools and interactive approaches to innovation. Several participants argued that the R&D organizations involved became more positive and proactive in participating in regional collaborations. This implies that the R&D organizations gained insight into how, and why, participation in forums and networks is important for regional development. However, it appears that this again was linked to individual researchers involved without necessarily changing the systematic practices of an R&D organization. As typically argued, the complexities of R&D organizations make it difficult to achieve thorough changes.

> *There are faculties or single researchers, or groups of researchers, who see the value of [VRI], using it systematically and working systematically*

> *with it. But in the organizations… it's difficult. […] Getting a university to co-operate is difficult because of their incentives, financial systems and the diverging expectations, making them different from [the logics of other organizations]*. (County Administration Representative)

This quote also serves as an indication of the degree of learning in the R&D organizations. Because this is linked in many instances to individuals, it appears that there has been a minor learning outcome from VRI for the R&D organizations. This is not surprising and should be expected. Changing organizational practices in a university is of course difficult—if not impossible—for a programme like VRI (Morgan 2017). Therefore, it is interesting to note that the participants emphasized the role of VRI in opening parts of the university and university colleges to regional industries; indeed, there have been several success stories where lasting relationships and personal networks have developed and matured over time.

> *I believe [the R&D organizations] have understood that they need to become more extrovert and take part in development processes. They understand the politics now. You cannot sit in your own office and do research; you must take part in the development of the region […]. And I think we have some researchers who have become quite good at that.* (County Administration Representative)

In sum, we found that VRI to a minor degree contributed to changes in how R&D organizations work with innovation. According to the participants, real changes occurred in parts of the R&D organizations, but rarely at the strategic level.

County administrations

County administrations have played an important role in VRI. In most cases, they were project managers and co-ordinators of the regional VRI projects and were prominent in the regional partnerships. In general, the county administrations have used VRI as a strategic tool for regional development. Interestingly, it appears that they took a more proactive role in regional development because of VRI. Several of our participants noted the importance of VRI in positioning county administrations as important players in the RIS. Through taking positions as leading actors in project development and implementation, this has also resulted in significant learning in most of the county administrations. One participant commented:

> *With VRI, the county administrations, or the regional level, were given a role in research. That position has been largely extended with the introduction of Regional Research Funds. Looking at it like that, VRI has created new understandings in the regions on how [the county administrations] can take a role in research activities.* (County Administration Representative)

Several of the county administrations appear to have 'found their role' in supporting R&D activities through co-ordination and stimulation of linkages between actors. This learning was also largely internalized and it has led to changes in how the county administrations work with R&D, innovation and regional development.

> *You can say that those who have been working on VRI, they have learned a lot. That is valid for the whole Regional Development Department [in the County Administration] […]. So it is not just individuals, it is the whole department.* (Representative from R&D Organization)

> *For us [in the County Administration], VRI has led to big changes in the way we work. For instance, we wouldn't have had comprehensive innovation work reaching far into industry, changing structures and relations, if [it wasn't for VRI].* (County Administration Representative)

Thus, we find that county administrations have had a high learning outcome from participation in VRI. This is linked to their role as co-ordinators of activities in the RIS, and they have taken a proactive role in this work. In turn, this has led to practical changes in organizational practices.

Overall, we found that on the actor level, VRI contributed to a high learning outcome in county administrations, moderate in firms, and minor in R&D organizations, although regional differences are considerable. Projects targeted towards certain industries/firms appear to have benefitted the most, which implies that former experiences with R&D and innovation have been beneficial for achieving high learning outcomes from VRI at the actor level. In contrast, successful developments of R&D–industry linkages have proven difficult in areas where involved organizations can be classified as inexperienced with such work.

System level

The second important dimension of the VRI programme was to develop strong and well-functioning partnerships that were expected by the RCN to consist of relevant regional R&D organizations, industry facilitators, cluster organizations and regional development agencies, among others. Moreover, to be granted funding for their projects, the regions had to link their VRI projects to other regional strategies (e.g. the county administration strategies for regional R&D) and show how the VRI linked to existing policy tools, such as the Regional Research Funds policy programme.

Consequently, given the strong focus on this interlinkage from the national level, our analysis found that development of regional partnerships is an important outcome of VRI. Moreover, the partnerships have had a high learning outcome from VRI.

The regions put much effort into development of these regional support structures for innovation. Interestingly, we found that the distinction presented above (between experienced and inexperienced organizations) is also relevant when explaining regional differences at the system level. Because some regional partnerships already had experience in working with system-oriented policy tools and had established partnerships, these regions can be classified as having a (relatively) well-functioning support structure prior to VRI involvement, or at least that they had a certain extent of experience with this way of working with regional development and innovation. In practice, this meant that some regions could start off their projects by developing the actor level (i.e. initiate practical activities at an early point in time), whereas other regions struggled and expended much time and effort on developing regional partnerships, given that these were required to be developed (see Anonymous and Anonymous 2017). One participant explained how they began with a strong focus on developing the support structure.

> *We've been working a lot on developing innovation systems, collaboration and arenas for collaboration, and that we are capable, as a region, to do these things. And then we, of course, score worse on for instance development of R&D projects with firms.* (County Administration Representative)

This theme is supported by another participant from a different region, who noted that the regional partnerships struggled to 'understand' VRI.

We created a working group, involving [the relevant actors]. […] We were trying to find out which themes to include [in the application]. But no plans existed, no industry development plans, no R&D plan... We had nothing to relate to... So, basically, we sat down and decided what was most relevant for [our County]. (County Administration Representative)

In regions inexperienced with working through regional partnerships, the RCN directed development of the projects to some extent through application procedures where the rejected applicants were given the opportunity to resubmit their revised project applications based on feedback from the RCN. Especially during the early phases of VRI, the regional partnerships found it difficult to develop well-functioning linkages at the strategic level and link these to their practical activities. However, our participants recognized the importance of such a mode of operation. In regions with well-functioning support structures, stimulating interaction between actors in the regions was put high on the agenda from an early stage of the programme. This is exemplified by a participant from a region that was experienced in working through partnerships before VRI was introduced:

[Here] we have, over time, had a partnership across institutions, both R&D institutions, the research council, the County Governor… which has been satisfactorily co-ordinated. […] I believe that was a very important success factor for us. (County Administration Representative)

As a result of VRI, more actors than before have actively participated in regional development activities. Industry and R&D organizations have been incorporated into regional activities at a strategic level, which enables development of a platform for policy implementation and shared understandings that in turn leads to the development

of a support structure for innovation. Thus, learning outcomes are highest at the system level (Table 3). Moreover, despite the regional differences, RIS understanding has gained a stronger foothold throughout the programme in the involved regions. The participants emphasized the importance of development of the support structure for innovation as important for success in stimulating interlinkages and activities among actors in the region. This emphasis shows that VRI has changed practices for innovation at the system level. However, when exploring this and linking it back to the distinction between inexperienced and experienced regional partnerships, it appears that VRI has developed inexperienced partnerships towards a more mature position, whereas already well-functioning partnerships before VRI have been given leeway to develop towards strengthening the actor level and working in a more focused way towards stimulating interaction between regional organizations. Therefore, a main outcome from the VRI programme has been the strengthening of the regional support structure for innovation, where better co-ordination between the actor groups, development of shared understandings, trust and delineation of tasks have been strengthened. In general, this is valid across all regions and is a finding that gained strength as the VRI programme progressed.

[Insert Table 3 about here]

Discussion

Given that the VRI programme was in operation for 10 years and that funding for the programme was predictable and long term, the regions were able to make long-term plans for development of their projects right from the outset of the programme. This

gave regions inexperienced with working through partnerships time to develop these, while regions with well-functioning support structures were able to develop these further, and simultaneously experiment with new tools. Thus, we found that the VRI programme primarily stimulated development of the system level in Norwegian regions. We also found that how the regions responded to the programme was the result of their pre-existing experiences at the actor and system levels.

As discussed in the theoretical section, theoretical accounts and policy advice highlight the importance of developing both RIS actors and the support structure. However, a region can be characterized by innovative firms and R&D organizations, but this does not necessarily imply that the support structure for innovation is well-functioning or adapted to these organizations (Zukauskaite et al. 2017). Moreover, as RIS theories are relatively ambiguous as to whether RIS evolve bottom-up or top-down, this paper has shown that a reasonable assumption based on theoretical discussion is that RIS evolution is the result of the dialectical dynamics between bottom-up and top-down processes. However, the discussion of the VRI programme shows that RIS theories and policies should acknowledge that regions differ in terms of whether it is bottom-up or top-down processes that characterize the evolution of the given RIS. This means that RIS policies should be sensitive towards balancing the development of actor and system levels because the balancing point between these levels differs between regions. In the case of VRI, which lasted for 10 years, it appears that in regions inexperienced with regional partnerships, the RCN exerted their influence through strict application processes where the regional partnerships were guided towards an understanding of what a RIS is. In these regions, it appeared to be important to have a certain degree of top-down implementation of RIS policies. Conversely, in regions with well-functioning support structures, more leeway was given from the RCN and regional

partnerships worked more bottom-up, i.e. the policies targeted the organizational level. Thus, we concur with recent contributions that argue for the importance of considering that different regions have different opportunities for RIS development, but that not all regions require the same process (Isaksen and Trippl 2016). However, we believe there is a need to deepen these discussions considering the separation of the actor and system levels, and that RIS policies should be adapted to this. Following this logic, it would mean that the development of RIS is particularly difficult in some regions, e.g. regions where both the actor and system levels are inexperienced with R&D and innovation. These areas face particular difficulties in RIS evolution. In addition, we argue for greater consideration of the fact that the practices of the three actor groups in the triple helix differ. In the literature, there is a tendency to treat triple helices as relatively homogeneous (Morgan 2017). However, as earlier discussion has shown, organizations can react differently to the same policy (Njøs et al. 2014). In the case of VRI, the programme proved particularly beneficial for the county administrations but to a lesser extent for firms and R&D organizations. Thus, having an idea of which organizations are to be the target of RIS policies appears important, again implying that policy implementation should be linked to knowledge of the practices and capabilities of organizations in the RIS. Thus, as argued by Zukauskaite et al. (2017), considering both organizational and institutional specificities is important when targeting development of regional economies, but also that interlinkages between the two levels should be given specific attention. This also links up to claims that much RIS research has focused on studying firms and/or R&D organizations and far less so intermediating organizations (Doloreux and Porto Gomez 2017).

Conclusion

Based on our theoretical discussion, this paper has exemplified how RIS theories reflect the discussions within innovation studies on the role of actors and structures in the evolution of regional economic activity. The lack of consensus concerning which level should be approached is also reflected by RIS policies, where both actor-centric (i.e. bottom-up) and system-centric (i.e. top-down) policies often operate side-by-side, but also where, in theory, the policies are expected to work best if the two approaches are combined (Isaksen and Jakobsen 2016; Boschma et al. 2017; Isaksen et al. 2016). Considering these points, this article has developed a framework that is sensitive towards the theoretical discussion on RIS evolution and its interlinked policy implications. We positioned our framework in evolutionary theory. Based on the theoretical discussion, it was argued that RIS policies should stimulate the dialectical interplay between actors and system levels (cf. Zukauskaite et al. 2017) through supporting learning processes. Hence, an implication of this is that policies should target organizations in RIS and the support structure simultaneously. However, through an empirical investigation of the Norwegian RIS policy programme VRI, which aimed to stimulate learning outcomes both in organizations and regional partnerships, we found that this theoretical assumption should be deepened. More specifically, our investigation showed that learning outcomes were linked to the *a priori* experiences with innovation and R&D at both levels. Whereas regions with well-functioning support structures before VRI involvement appeared to focus more on development of organizations in the RIS, regions inexperienced with regional partnerships spent much more effort on development of these partnerships. Moreover, we found that the VRI programme has generally stimulated development of support structures for innovation, but less so changes in practices in the organizations. In VRI, three actor groups were

specifically important: county administrations, firms and R&D organizations. We found that VRI has changed how the county administrations work with innovation, while firms (to a moderate extent) and R&D organizations (to a minor extent) have learned less from the programme.

This paper has contributed to RIS theories through the development of a framework that is sensitive towards both organizations and support structures in RIS development. We have shown that both these levels and their interplay should be considered by RIS theories and policies. Concerning the role of policy, it has been argued that policymakers should consider regional differences, but that regions with poor support structures appear to benefit more from top-down intervention when the aim is to develop well-functioning support structure. Moreover, we have contributed to the discussion on the role of policy in RIS evolution in regions characterized competent and innovation- and R&D-experienced organizations. Such approaches are absent from the literature according to Doloreux and Porto Gomez (2017: 385), who noted that analyses have been 'silent on the conditions that enable growth to accrue in regions where innovation occurs, often assuming that the conditions conducive to innovation will automatically lead to growth'. Moreover, as argued by Zukauskaite et al. (2017), an important role for future research is to acknowledge that organizational and institutional thickness are not two sides of the same coin, and that one of the two does not necessarily lead to the other. In other words, we believe that future research should focus not just on the actor or system levels of RIS evolution, but that conceptual and empirical work should explore the mechanisms and interlinkages between the two levels. For instance, it is not sufficient to have competent firms and R&D organizations in a region unless these are linked together by a common institutional framework, i.e. support structures for innovation. Studies focusing on only the actor or system levels

necessarily miss out on such descriptions. Moreover, and maybe more controversially, this approach also considers—and acknowledges—the importance of top-down processes, at least in certain regions.

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Table 1. RIS evolution and the role of policy

Level	Policy target	Learning outcome	RIS evolution through
Actor level	Organizations; firms, R&D organizations, (public) development agencies	Changes in organizational practices	Bottom-up processes
System level	Support structure for innovation	Changes in facilitation practices	Top-down processes

Table 2. Linking theoretical, analytical and empirical concepts

Theoretical concept	Analytical concept	Operationalization/empirical concept
System level	Support structure for innovation	Regional partnerships
Actor level	Organizations in RIS, i.e. regionally embedded organizations	Organizations: firms, R&D organizations and county administrations

Table 3. Learning outcomes from VRI.

Level	Target group	Learning outcome	Main learning outcome
Organizational level	Firms	*Moderate*	Introduction to policy tools and the importance of utilizing research in innovation activity
	R&D organizations	*Minor*	Knowledge of regional industry, developing relations to other regional actors
	County administrations	*High*	Co-ordination and management of triple helices; what role to play in stimulating research in regional development and innovation
System level	Regional partnerships	*High*	How to co-ordinate regional resources, i.e. how to stimulate interaction and networking between regional actors and also how this is linked to regional challenges and opportunities