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# The scope of regional innovation policy to realize transformative change – a case study of the chemicals industry in western Sweden

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## ABSTRACT

Economic geography and innovation studies are increasingly asking how regional industrial development paths develop. This paper addresses the scope of regional innovation policy to influence transformative change in regional industries, such as that needed to cope with grand societal challenges including climate change. We take a cross-disciplinary perspective using the regional innovation system framework, which is focused on innovation-based regional development, and complement this with insights from the sociotechnical transitions literature and its conceptualizations of sociotechnical regimes and niches. Empirically, we study the case of the chemicals industry in the Gothenburg–Stenungsund region, Sweden’s largest basic chemicals industry cluster. Shifting from discussion to action appears challenging for this regional industry, despite advances in technology development, ongoing co-operation between the region’s public and private sectors and its ambition to become an international leader in the production of sustainable chemistry products by 2030. Using this case, we present a broader view of path development, one that includes under-addressed policy approaches attempting to create new sociotechnical alignments that require co-evolving changes across technologies, infrastructures, regulatory frameworks and other societal dimensions, both within and beyond the regional context.

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## 1. Introduction

In economic geography and related disciplines, there is an increasing interest in how new regional industrial development paths emerge. Previous research has shed light on different forms and mechanisms of path-dependent regional economic evolution (Boschma & Frenken, 2011; Martin, 2010) and increasingly emphasizes institutional and policy roles as drivers of regional industrial change (Dawley, 2014; Martin & Coenen, 2015; Martin & Martin, 2017; Simmie, 2012; Steen, 2016). Less often addressed,

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however, is transformative change (Coenen, Hansen, & Rekers, 2015), which places new demands on innovation directionality through critical reflection on normative issues such as the nature of growth, well-being and human values (Healy & Morgan, 2012; Weber & Rohracher, 2012). Transformative change is needed to address grand societal challenges, including environmental concerns such as the growing volumes of waste, climate change and pressures on natural resources.

This paper argues for a stronger consideration of transformative change in the regional economic evolution literature (Frenken, 2017). It attempts to make the regional innovation systems (RIS) framework more compatible for addressing societal challenges. RIS have increasingly been applied to conceptualize and explain new regional industrial path development, especially focusing on the role of policy in regional economic evolution (Asheim, Isaksen, Martin, & Trippl, 2016; Isaksen & Trippl, 2016, 2017; Martin & Martin, 2017; Tödtling & Trippl, 2013). Contributions have addressed support for knowledge creation and recombination between firms and the RIS knowledge infrastructure (Asheim et al., 2016; Isaksen & Trippl, 2016; Strambach & Klement, 2013), promoting a supply-focused view of innovation. Only very recently have contributions explicitly expressed the importance of the multiple roles of demand and their policy implications for regional development and transformation (Martin, Martin, & Zukauskaitė, 2019).

Societal challenges make challenge-driven innovation necessary, meaning that technical solutions must co-evolve with new behavioural patterns both at the societal and individual levels (Edler, Georghiou, Blind, & Uyerra, 2012; Healy & Morgan, 2012; OECD, 2016). They require a broader focus on creating appropriate alignments to solve, or extenuate, a persistent societal problem<sup>1</sup> and necessitate altered production and consumption patterns, which must co-evolve with changes in technologies, infrastructures, regulatory frameworks and other societal dimensions (e.g. lifestyles) (Borrás & Edler, 2014; Geels, 2002). Transformative change, therefore, also requires paying attention to innovation adaptation and diffusion (Edler et al., 2012; Mowery, Nelson, & Martin, 2010) and policy co-ordination (Grillitsch, Asheim, & Trippl, 2018).

This paper's objective is to highlight RIS actors' potentials, and limitations, for influencing transformative change. We address this issue using a policy perspective on RIS, by taking a cross-disciplinary view on sociotechnical transitions and using the concepts of sociotechnical regimes and niches (Geels, 2002; Schot & Geels, 2008). We specifically draw on the notion of protective space, usually used to conceptualize and analyse how sustainable innovations emerge, grow and decline, in the established innovation systems context (Raven, Kern, & Smith, 2016; Schot & Geels, 2008). Despite notable contributions (Coenen, Moodysson, & Martin, 2015), sociotechnical transitions in general, and particularly the notion of protective space, lack an explicit spatial perspective (Coenen, Benneworth, & Truffer, 2012; Hansen & Coenen, 2015). Hence, this specific theoretical contribution of this paper is to bring together the notion of protective space (Smith & Raven, 2012) and the RIS framework.

Empirically, this paper is a case study of the chemicals industry in the Gothenburg–Stenungsund region of Sweden's west coast, which is the country's largest basic chemicals industry cluster and a heavily polluting, fossil resource-intense industry. The region can be classified as a core region, offering advantageous preconditions for new path development (Boschma, 2015; Isaksen & Trippl, 2016). Moreover, it holds high potential for increased production and use of bio-based chemical and material products and renewable

energy. This potential is due to existing firms' research orientation, institutes and academia targeting the bioeconomy, ongoing co-operation with northern Sweden's forest industry, and a district heating infrastructure with potential for increased regional energy efficiency (Suurs et al., 2013). Technology development is progressing in this region, co-operation between the region's public and private sectors is ongoing and its actors have stated their ambition to become the leading producer of sustainable chemistry products by 2030. However, shifting from discussion to action has proved difficult for this regional industry, necessitating actions that have been under-addressed in the systemic regional innovation policy literature.

Hence, we ask the following research questions: 'How can a core RIS influence the transformation of a heavily polluting industry? What are the potentials and limitations of regional innovation policy to bring about transformative change?'

In Section 2, we develop a conceptual framework for analysing regional policy processes for transformative change. Section 3 introduces the empirical case and explores the barriers and limitations of regional innovation policy to transformation. Sections 4 and 5 respectively discuss and draw conclusions on the main findings and provide suggestions for policy action and future research.

## 2. Theoretical framework

### 2.1. *New path development in RIS*

The RIS literature has advanced our understanding of innovation-based regional development. It argues that endowing regions with knowledge infrastructure (such as universities and research institutes) and firms is crucial for regional-level innovation to occur. These are commonly referred to as the knowledge exploration and knowledge exploitation subsystems, respectively (Autio, 1998). The RIS field also acknowledges the inherent influence of institutions and policies (directly or indirectly) in regulating actors' interactions and behaviours (Asheim & Gertler, 2005). The literature emphasizes varying regional preconditions for innovation, provides typologies targeting regions' differentiated innovation potentials and argues for the adaptation of region-specific, place-based policies to promote innovation (Asheim & Isaksen, 2002; Doloreux, 2002; Tödting & Trippel, 2005).

Although RIS have traditionally engaged in industrial dynamics, such as those in old industrial regions (Trippel & Otto, 2009), RIS scholars have only in response to the evolutionary turn (Boschma & Frenken, 2006), started to address more conceptually how new regional industrial development paths come about and change over time. Different types of regions have different capacities to develop new paths, depending on their organizational thickness and economic specializations (Asheim, Isaksen, & Trippel, 2019; Hassink, Isaksen, & Trippel, 2019; Isaksen, Martin, & Trippel, 2018). Organizationally thick and diversified core regions can benefit from the diversity of local industries, technologies and organizations, which offer potentials for combining different local competences and enable permanent economic reconfiguration (Martin & Sunley, 2006). Following these contributions, RIS constitute variety selection environments in that they provide and define preconditions for change. Other contributions emphasize that RIS changes can also come about via network and organizational changes, such as changes in a region's knowledge generation and diffusion subsystem (Tödting &

Tripl, 2013). This perspective places greater emphasis on the scope of change and the extent to which RIS constitute a variety creation environment for innovation. Martin and Martin (2017) identified the importance of formal capacities (political autonomy and financial assets) in combination with historically grown interactions in RIS as crucial for advancing regional path development.

However, the central tenet emphasizes strengthening knowledge creation and recombination within and between the RIS knowledge exploration and exploitation subsystems. In core regions, these may occur through firm- or research-driven processes, based on a strong organizational support structure (Isaksen & Tripl, 2016). Subject to their organizational endowment and the degree of related variety, RIS require different policy interventions to stimulate new path development. This again implicates the role of policy in identifying, facilitating and strengthening combinatorial knowledge dynamics between firms and the RIS knowledge infrastructure (Asheim et al., 2016; Isaksen & Tripl, 2016; Strambach & Klement, 2013).

For transformative change, innovation system change will, however, not only depend on firms' adaptation and novelty creation capacity, but equally on the capacities of the public sector to induce societal change, and on the diffusion of innovations (Edler et al., 2012; Healy & Morgan, 2012; Mowery et al., 2010). Sociotechnical transitions provide a valuable framework for highlighting important policy processes during transformative change.

## **2.2. Sociotechnical transitions and properties of protective space**

Sociotechnical transitions provide an explanation for technological change within the context of established, historically grown and privileged regimes (Geels, 2002; Geels, Hekkert, & Jacobsson, 2008). As the main components, 'sociotechnical regimes' are the 'coherent complex of scientific knowledge, engineering practices, production process technologies, product characteristics, skills and procedures, established user needs, regulatory requirements, institutions and infrastructures' (Kemp, Schot, & Hoogma, 1998, p. 338); in other words, the selection environment for innovation. They primarily render incremental innovation possible, accumulating to existing paths (Coenen, Moodysson et al., 2015).

Radical, path-breaking innovation emerges in 'niches', spaces that protect against mainstream selection pressures that operate in regimes (Kemp et al., 1998; Raven, 2005). Niches are 'locations for learning processes, e.g. about technological applications, user preferences, public policies, symbolic meanings' (Geels, 2004, p. 912). In contrast to regimes, the structuration in niches is considerably lower and in flux. Niches can thus be seen as protective spaces that allow deviation from the pressures that operate within regimes. They provide learning opportunities regarding both technologies and other regime dimensions. A successful niche maturation process can result in upgrading and transforming regime structures. Niches possess three properties in the wider transition process: 'shielding', 'nurturing' and 'empowerment' (Smith & Raven, 2012).

'Shielding' targets 'processes that hold at bay certain selection pressures from mainstream selection environments' (Smith & Raven, 2012, p. 1027); in other words, it addresses the construction of protective space. Protective spaces can be passive in the sense that pre-existing, favourable places already exist for exploitation; they can also be actively created by strategic, purposeful action through specific interventions by advocates of path-breaking innovations. Shielding can originate via either public or private actors.

Raven, Kern, Smith, Jacobsson, and Verhees (2016) found that advocates of niches first use pre-existing, passive spaces before strategically creating active spaces.

'Nurturing' involves 'processes that support the development of the path-breaking innovation' (Smith & Raven, 2012, p. 1027) and is the most researched niche property (Raven, 2005; Schot & Geels, 2008). Nurturing is based on three niche-internal processes: articulation of expectations, building of social networks and second-order learning processes. Successful niche development is based on robust, specific and high-quality expectations if they are shared by many actors, they are specific and are of high quality. Social networks contribute if their membership is broad (i.e. if they provide plural perspectives) and deep (i.e. if its members commit substantial resources). Learning processes must be broad and generate second-order learning about alternative socio-cultural values and diffusion implications (Hoogma, Kemp, Schot, & Truffer, 2002).

'Empowerment' targets interactions with the niche-external regime environment and can take two forms: first, empowerment through fit and conform as 'processes that make niche innovations competitive within unchanged selection environments'; and second, empowerment through stretching and transforming, 'processes that re-structure mainstream selection environments favourable to the niche' (Smith & Raven, 2012, p. 1030). However, stretching and transforming processes will not occur entirely niche internally, but will, 'rely upon other processes of change within the regime and in the broader society and economy' (Smith & Raven, 2012, p. 1030). Therefore, not all niche developments are likely to lead to full transformations. Raven et al. (2016) found that, in practice, a mixture of both fit and conform strategies and stretch and transform strategies is often applied.

Shielding, nurturing and empowerment evolve over time, rather than being assigned based on specific events. Transformation advocates need to be involved in both niche construction and regime reconstruction and, importantly, these are non-linear processes (Smith & Raven, 2012).

### ***2.3. Shielding, nurturing and empowerment as RIS policy***

We will now apply shielding, nurturing and empowerment to describe the scope of RIS policy potentials and limitations to influence transformative change. We apply a broad understanding of RIS policy (Cooke & Morgan, 1998) as being the collective actions of both public and private actors. These actors are not only the passive targets of regional and supraregional policy interventions but are directly or indirectly able to shape policies and their outcomes (Flanagan, Uyarra, & Laranja, 2011; Uyarra & Flanagan, 2013).

'Shielding' addresses the scope of RIS to constitute and/or construct active or passive protective space against mainstream selection environments. Within the systemic regional innovation literature, shielding processes are described in recent contributions about vision-led regional development. So-called 'entrepreneurial visions' (Foray, 2014) or 'entrepreneurial discovery' are crucial for providing directionality and legitimacy for actors to engage in transformative change (Weber & Rohracher, 2012). Vision-led regional development must be understood as interactions between RIS actors (Asheim, Grillitsch, & Trippel, 2017) that requires setting priorities and aligning expectations, and is likely to be facilitated by a high quality of historically grown local interactions. These are crucial for achieving collective action and making use of an existing formal scope for influencing

regional development (Martin & Martin, 2017). In the context of transformative change, entrepreneurial discovery is likely to be based on expectations for changing societal norms, that is, a general increase in society's environmental awareness. Thus, regional visions aim to shield the RIS against mainstream national and international selection environments, not in terms of competition, but rather by providing a strategic intention for actors to join transformation efforts. This is consistent with recent contributions on how regional actors' purposive actions influence regional economic development by breaking with established technological paradigms and social rules (Grillitsch & Sotarauta, 2019; Isaksen & Jakobsen, 2017).

'Nurturing' of innovation has traditionally been attended to in the systemic regional innovation literature. For example, we know that learning processes benefit from geographical proximity, insofar as short geographical distances favour trust building and social interactions among actors (Coenen, Raven, & Verbong, 2010; Boschma, 2005). Up to a certain extent, social networks stimulate innovativeness and are particularly important in selection environments consisting of high uncertainty and a low level of formalized institutions (Grillitsch & Rekers, 2016). Closely related, regions that are strong at changing institutional context conditions provide promising settings for creating and maintaining favourable innovation and path development environments (Martin & Martin, 2017). Sociotechnical transitions highlight the importance of alignments between technologies, infrastructures and societal practices; yet the need for such alignments has been widely disregarded by regional economic evolution (for an exception, see Binz, Coenen, & Truffer, 2016). Furthermore, issues of adaptation and diffusion of innovations have been under-researched (Martin et al., 2019), aspects that are highly relevant to bringing about transformative change.

'Empowerment' addresses interactions with RIS-external institutional and policy environments. It attempts to influence subregional policy processes through stretch and transform strategies. RIS are generally nationally and internationally connected systems, embedded in supraregional institutional settings and knowledge networks (Asheim & Isaksen, 2002), and are influenced by demand patterns at various spatial scales (Malmberg & Power, 2005). Processes that facilitate interactions between RIS and their supraregional institutional environments, in order to influence the conditions for regional innovation and change, have received relatively little attention. Grillitsch and Rekers (2016) touch upon this by conceptualizing selection theory in the context of regional industrial dynamics, finding that selection processes become increasingly formalized over time. In the context of transformative change, RIS must be understood as entities embedded in a broader societal context. Important preconditions for establishing new sociotechnical alignments are, therefore, likely to lie outside the direct scope of RIS policy influence. Empowerment strategies are herein understood to be policy actions that facilitate new alignments between aspects such as technologies, infrastructures and societal practices, for example through exerting influence on supraregional regulatory frameworks. Thus, empowerment targets alteration of the mainstream selection environment that defines the preconditions for innovation within and beyond the regional boundaries.

Next, we consider shielding, nurturing and empowerment as RIS policy processes embedded into broader (political-institutional) contexts in our analysis of the transformation of the Gothenburg–Stenungsund region's chemicals industry. The regional context must be understood as frame for transformative change processes; yet acknowledging that



various actors and actor groups take agency within an innovation system, and that various regime-characteristics might be present inside the RIS.

### 3. Analysis

Our analysis is based on a combination of qualitative methods, using semi-structured, in-depth interviews as our main data source. Thirteen interviews with key stakeholders were conducted between December 2013 and 2019, emphasizing our long-term perspective on industry transformation. Interviewees were equally representative of regional firms, industry experts, policymakers and university representatives. Many were also previously employed at other chemical industry-related workplaces and thus possess rich knowledge about this case. The interview questions included the interviewees' views on: regional industry development in recent decades; their activities to bring about a transformation; the factors that drive and hinder transformation; the national and international significance of the regional chemicals industry; and perspectives on future development. Each interview lasted 45–110 minutes and was conducted in Swedish by the authors, who then translated important quotes into English for inclusion here. Although the interviewees had different backgrounds and positions, they showed general agreement regarding the potentials and barriers of RIS actors to influence regional industrial transformation. This analysis is also based on extensive study of documents, including websites, policy reports and other strategic documents, as well as the participation in several national workshops targeting renewal of traditional industries in Sweden. For cross-checking purposes, the empirical material collected and analysed for the case under study, were supplemented with 12 additional in-depth interviews during 2012 and 2018–2019 regarding two related regional cases, respectively. The insights gained from these cases affirm the value of conceptualizing RIS policy processes for transformative regional industrial change as shielding, nurturing and empowerment.

This research adopts a critical realist view as its ontological position (Bhaskar, 1975; Sayer, 1992), considering research as an ongoing process, which is temporary and revisable. Incorporating ideas about sociotechnical transitions within shielding, nurturing and empowerment provide a novel view on policy processes, with RIS embedded into a broader, changing sociotechnical context. This perspective allows a new process of abstraction, aimed at improving RIS as a concept for understanding a changing social world.

#### 3.1. Regional and industrial context

The Gothenburg–Stenungsund region is part of West Gothland (Västra Götaland) and is home to nearly 20% of the Swedish population (VGR, 2015); the regional capital Gothenburg is Sweden's second largest city. The region hosts Sweden's largest trade port, providing access to the North Sea and the Atlantic, and has historically been a strategic hub for both Swedish exports and international imports to Sweden and Scandinavia. Second to shipping and trade, manufacturing (particularly automotive and textiles) has been an additional historical stronghold in West Gothland. Today, the automotive and transport industry, trade and logistics, chemicals, information and communication technologies, industrial electronics, life sciences and cultural and creative industries constitute the region's economic strongholds (BRG, 2019; Lindholm Dahlstrand, 1997; VGR, 2016).



West Gothland possesses a strong and diversified higher education sector, including two of Sweden's largest universities, Chalmers University of Technology and Gothenburg University, which are also recognized for their knowledge creation related to sustainable development (Suurs et al., 2013). The region is well endowed with many research institutes, including the Technical Research Institute of Sweden (SP), the Swedish Environmental Research Institute (IVL), the Swedish Institute for Food and Biotechnology (SIK) and intermediary organizations. Rich collaborations exist between these universities and firms (Lindholm Dahlstrand, 1997). The county also enjoys devolved powers, facilitating the creation of sustainable regional growth and development (Sveriges Riksdag, 2010; VGR, 2017), and this political autonomy is considered important for new path development (Martin & Martin, 2017).

### **3.2. Regional chemicals industry**

#### **3.2.1. Regional background and preconditions**

The chemicals industry began to emerge in the coastal town of Stenungsund, to the north of Gothenburg, during the mid-1950s. An important initial development was the construction of a steam power plant in Stenungsund, due to its advantageous transport connections. With this secured power supply, direct port access and suitable building land, chemical industry companies showed interest in Stenungsund. During the mid-1960s, Scandinavia's first cracker plant began operations at the site, establishing its crucial position in the Swedish and Scandinavian petrochemicals industry. Since then, the region's chemicals industry has gradually developed and expanded (Berglund, 2010; Stenungsunds Kommun, 2018).

Today, five large chemical companies (AGA, AkzoNobel, Borealis, Ineos and Perstorp), establishments of global, multinational corporations, are located at the Stenungsund site. These companies focus on both fuels and materials production, including handling large quantities of raw materials. Furthermore, these firms have high export shares and divisions of establishments of global, multinational corporations. They have traditionally collaborated on mass and energy flows, which they exchange through a commonly owned infrastructure (Berglund, 2010; Suurs et al., 2013).

#### **3.2.2. Initiating regional transformation**

In 2009, the regional government, Västra Götalandsregionen (VGR), decided that the region's economy would be independent of fossil resources by 2030. This was an ambitious reaction to the Swedish parliament's vision that the country's energy supply would be free of net greenhouse gas emissions by 2050. The strategy was signed by more than 60 municipalities, organizations and firms, based on a common belief in a high regional transformation potential due to the presence of important industry representatives, a strong research environment, forward-looking public actors and many good ideas (VGR, 2009). Regional public actors and the chemical firms increasingly saw the important role that the chemicals industry could play in this transformation:

Ten years ago, the regional authorities started to consider that they [the chemical companies] had a key role to play in this transition towards a higher degree of renewables in our society. (...) And taking this vision as point of departure, the chemical companies also realized that they had a very important role to play in this. (...) They realized that there was a marketing value for their industry. (Representative, business development office)

From a global perspective, the chemicals industry is steadily growing. Even, the European chemicals industry global market production and sales are increasing in absolute numbers. However, its global market share has decreased dramatically over the past 10 years. In 2011, the five Stenungsund companies initiated the ‘Sustainable Chemistry 2030’ vision (Hållbar Kemi 2030) stating that by 2030, Stenungsund would be the production hub for renewable chemical and material products, and would lead resource and energy efficiency through recycling, process integration and improved use of excess heat (Kemiföretagen i Stenungsund, 2014):

You do not feel the pressure from your customers, but you can see maybe far ahead that the market is changing and if you don’t change, maybe you’re not going to stay competitive. (Representative, technical research institute)

Since then, the visions of the region and the companies have aligned, based on their awareness of a close interdependency. The chemicals industry is simultaneously a large polluter and an important employer in the region:

We have to start with the chemicals industry to show effects in the other industrial sectors. And if they can go for it and it becomes a big market and demand, it will create jobs, of course. (Representative, business development office)

And then I also think that the society and economy in the long term are heading towards an increased independence on fossil fuels. This is essential and we demonstrate loyalty to all who anticipate that there will be a transformation. And when such a transformation occurs, then it is important that there are products ready that are technically sound and competitive. (Representative, county council)

This endeavour aims at actively shielding the regional industry against mainstream selection environments at the national and international levels, based on an entrepreneurial vision of strengthening the region’s competitive advantage. It is based on a belief in changing societal norms towards increased environmental awareness and well-being, and reduced pollution, potentially changing societal demand patterns and markets. Vision-led development and priority setting are facilitated by historically strong interactions between regional actors (Martin & Martin, 2017):

What is driving the chemicals industry in western Sweden is the belief that there is a possibility to stick out, that we have a niche. (Representative, cluster initiative)

In our area here in western Sweden, there is a co-operation that I think is unique. There is a close proximity to each other. (...) Between firms, the public sector and academia. (...) I believe there is a spirit of co-operation and a common mindset here. (...) ... It has evolved over many, many, many years, I would say. I do not think it is enough to say 100 years. (Representative, business development office)

Moreover, the existence of both organizational and industrial diversity and a physical infrastructure (e.g. a district heating grid with the potential to both reduce the industry’s high energy costs and increase its energy efficiency) is an important precondition for regional transformation. They are crucial for the initial mobilization of passive spaces and, by implication, a regional selection environment through which protected spaces can be created more actively and strategically (Raven et al., 2016).

### 3.2.3. *Barriers to transformation*

Several relatively small steps have been taken to achieve the vision of a fossil-independent regional economy by 2030. However, only 10–15% of the raw material inflow to the industry is bio-based (VGR, 2019b), while the region in general and the chemicals industry in particular face a number of largely interrelated, regime-based barriers to transformation (Kemp et al., 1998). Major market obstacles and established user practices make it economically unjustifiable for companies to make the necessary large investments. This is because appropriate national and international policy incentives are absent and oil prices are relatively low. While some incentives targeting bio-based fuels (e.g. tax exemptions for vehicles) have led to investments, bio-based materials are hardly supported by current regulations. Use of the excess heat from chemical companies is hampered by regulatory settings that disallow classifying district heating as environmentally friendly. Different local grids would need to be connected to a region-spanning grid. Given that district heating is a municipal task, there exist, however, several barriers with regard to risk taking for which new organizational forms and business models must be established (Mossberg, Thomtén, & Karlsson, 2015). Moreover, national funding schemes for the chemicals industry are absent (Mossberg, 2013), as is a national bioeconomy strategy (Naturvårdsverket, 2019), both of which hamper industry reorientation. Although some crucial technologies are in place for transformation, there is no clear view about which technology is the best alternative and further development is required. While many small-scale demonstration projects have been conducted, new business models that allow reasonable solutions to investment risk-taking are yet unproven and demonstration plants are needed (Suurs et al., 2013). Another crucial obstacle is the dearth of individuals with the appropriate skills on the job market. This is a problem closely connected with the negative image of the chemicals industry (Mossberg, 2013; Mossberg et al., 2015), causing amongst others stagnating employment in bio-economy related occupations in the regional industry (VGR, 2019b).

### 3.2.4. *Regional action targeting transformation*

Despite these barriers, regional actors are working to influence an industry transformation. In recent years, to address a broader range of actors, the cluster initiative has undergone several phases of renaming, from the ‘Chemical Industry Cluster’ to ‘The West Swedish Chemicals Cluster’ to the most recent ‘West Swedish Chemicals and Materials Cluster’. The geographic focus has increasingly shifted to Gothenburg and the cluster has grown to more than 20 members, spanning a variety of companies, research institutes, universities and public actors (Suurs et al., 2013). The initiative’s host changed from a public business development agency, Business Region Göteborg (BRG, 2019), to a science park at Chalmers, the technical university. It is thus still in flux, demonstrating that new path development co-evolves with social network changes and RIS elements (Smith & Raven, 2012; Tödting & Trippel, 2013). The broader focus on materials emphasizes activities to incorporate customers (described in detail below) to achieve commercially viable outcomes, which requires extensive co-operation between academia, companies and public authorities (Suurs et al., 2013). Attempts have been made to bring together industries by creating an extended value chain of industry actors who must be involved for transformation to occur (i.e. rather than involving industries based on an industry-based code):

We have Södra [a foundation of forest owners], we have those who produce plastic components, we have the Volvo companies that can use that particular type of material in their vehicles and then we have fuels. Then I would like to connect it with cultural and creative industries as well. [...] We want to connect those rather ‘unexpected’, ‘unpredicted’ industries with one another. (Representative, business development office)

I still believe that this with the NÄrodlat Plast [a locally produced plastics demonstration project] is very good. Because IKEA is in there, and so is ICA [a Swedish grocery chain] ... very large companies. They say that they want this; they should be prepared to pay a little extra for it. Not out of kindness I suppose, but primarily because they think that it will improve their image. (Representative, cluster initiative)

Nurturing thus occurs through broadened membership and learning processes with potential consumers (Smith & Raven, 2012). Expectations about changing societal values and competitive advantages are shared throughout the value chain. The cluster initiative is also actively teaching the industry to make new demands and shape its skilled labour force:

That they [the chemical companies] begin to transform, to think a bit differently when they recruit. And then also the universities and other educational bodies have to keep up and make sure that people get the right training. In the chemical industry cluster, for example, we have achieved that the companies are part of the instruction councils and form the focus of the courses and educational programmes according to their needs. (Representative, business development office)

Moreover, the region is shielding itself through regulatory pushes:

The political visions here are stronger than the national ones. (...) because there is a will to be present and to help push it so that it goes faster all the time. (Representative, business incubator)

Regional actors also realize that increased communication with political actors is required to create the conditions necessary for transformation (Suurs et al., 2013) based on existing technologies. Thus, the cluster is using empowerment strategies that educate national decision makers in regulation formulation (VGR, 2009):

Often the demands made are too low with regard to environmental, energy and climate issues. This is because of poor competence regarding what exists on the market. We try to hold various workshops and seminars to train those who sign procurement documents. (Representative, business development office)

As West Gothland constitutes an economically diversified core region with considerable national economic impact, such an empowerment strategy is influential. Empowerment is also practised abroad, in combination with market development, by identifying potential foreign public technology customers, such as district heating solutions. The cluster has engaged an event firm, Göteborg Company, to attract large congresses and events to the region, to spread knowledge about solutions.

The Sustainable Chemistry 2030 vision of the five chemical companies has largely been perceived as a successful empowerment of regional strategies and has influenced suprarregional selection pressures in ways that favour the region:

They [the large chemical companies] are viewing it as a communication project (...) to gain access to arenas where you have the attention and ear of politicians. (Representative, technical research institute)

The logic is that we are not seeing that we can make any investment today as we need the conditions to change, by using communication as a means. (Representative, technical research institute)

With such close alignment, empowerment realized by the companies' vision also leads to benefits for the regional strategy at large. Transformation of the chemicals industry has also been assigned an increasingly important role in the regional economic strategy (VGR, 2009, 2013) and the new strategy for 2021–2030 currently under development (VGR, 2019a).

However, the chemical companies' vision has also been described as having an unfeasible timeline and lacking common action (Mossberg et al., 2015; Suurs et al., 2013). It is informally built around engaged individuals, implying that not all companies are equally interested and that formalization of the vision may be needed (Mossberg et al., 2015; Suurs et al., 2013) to achieve deeper commitments from actors (Smith & Raven, 2012). Recently, the regional government (Västra Götalandsregionen) and the County Council of West Gothland (Länsstyrelsen i Västra Götalands län) have launched a Climate 2030 initiative (Klimat, 2030) to engage RIS actors in voluntary climate actions. It can be considered as another endeavour to spur purposeful action (Raven, Kern, Smith et al., 2016) to reach the regional 2030 targets through broadened membership and learning processes about alternative socio-cultural values (Hoogma et al., 2002). While many companies, municipalities, branch organizations and associations have engaged in the initiative to reduce greenhouse gas emissions (Klimat, 2030, 2019), thus far the five large chemical companies have not joined the initiative, which is largely, but not exclusively, due to a lack of legitimacy for change by their parent companies. Their recent environmental actions target instead ocean pollution reduction at the Stenungsund site.

This emphasizes the limits to achieving a full transformation of large-scale industries within the regional context (Coenen, Moodysson et al., 2015). Currently, the non-incumbent actors affiliated with the science park are more strongly associated with driving change momentum. The regional authorities have taken lead in putting into practice the 2030 ambitions. The most recent activities have included residents as an actor group in the formation of the new regional development strategy (VGR, 2019a), constituting another example of involving plural perspectives in the RIS and achieving broad network membership. Furthermore, the regional government has committed resources to procure bio-based plastics for public use to achieve change momentum and alternative socio-cultural values (Hoogma et al., 2002); current projects include the use of hospital sector biodegradable mugs, although this draws on the Brazilian sugar cane industry.

#### 4. Discussion

The approach used here allowed analysis of specific policy processes targeting both RIS-internal policy as well as interactions with RIS-external institutional environments. Shielding, nurturing and empowerment (Smith & Raven, 2012) have been used to describe the role of sociotechnical alignments for regional transformative change.

Shielding is based on expectations of altered societal norms, demand patterns and future product markets, which are assumed to lead to a first mover advantage of the region. This becomes apparent within the formulation of an industry-spanning vision

and ambitious environmental regulations. This is further supported by complementary initiatives that aim at putting regional targets into practice. Nurturing focuses on the extension of networks and on facilitating learning processes among a broad variety of actors. Specific examples are customers' involvement in learning processes about alternative socio-cultural values throughout extended value chains. Moreover, nurturing processes inform changes in the supply of, and demand for, skills and educational programmes. Empowerment is practised by training supraregional decision makers about the requirements that can be included in designing appropriate regulatory frameworks. All these processes reveal that niche building and protection must be considered as multidimensional constructs. They can take various forms and can be initiated by different RIS actors. They are often applied in close concert: shielding through a vision can imply empowerment as it potentially attracts the attention of supranational policymakers; and empowerment by teaching public decision makers can be aligned with nurturing processes that attempt to find new customers for technological solutions (e.g. public district heating).

Shielding, nurturing and empowerment also shed new light on RIS as variety-creation and variety-selection innovation environments. Transformative change must be considered in the context of mainstream selection pressures, which can be moderated within the regional context so that alternative sociotechnical constellations can form. The variety-creation capacity of the RIS appears to be of overarching importance. A history of strong interactions and a mindset open to experimentation among policy actors in the RIS facilitated vision-led development and priority setting. Crucial has been the ability and creativity to engage in and keep up the building and broadening of networks although severe hinders to transformation exist. These actions go beyond changes in the knowledge generation and diffusion subsystem and take a broader perspective on sociotechnical alignments.

The analysed case benefits from a rich variety selection environment in terms of diversity of regional industries. The core region has transformation advantages that more peripherally located regions presumably lack (Coenen, Moodysson et al., 2015). Economically diversified regions can more easily cope with the need to focus on adaptation and diffusion of innovations, as they are able to expand a narrow (supply-side) focus on technology towards markets. In the case under study, potential lies in actively connecting the chemicals industry with others, such as the automotive or creative industries. This implies policy actors' abilities to go beyond the established understanding of industrial relatedness and actively shape new linkages, for example through extending networks towards new actors. Regional organizational thickness can thus be supportive, although only if institutional change encompasses organizational adaptation; prevailing organizational settings may not necessarily support transformation. Again, this strongly links to the variety creation capacity of the RIS. Due to their economic impact, core regions are also likely to exert more influence on decision makers through their empowerment strategies than peripheral regions. Evidence is shown for the importance of a certain extent of regional legal autonomy in economic development decisions (Martin & Martin, 2017).

The novel perspective provided by shielding, nurturing and empowerment also pinpoints the lacking consideration of transformative change in types of regional industrial path development as they now stand (e.g. Asheim et al., 2019; Grillitsch et al., 2018; Isaksen et al., 2018). The presented case clearly involves mechanisms of path upgrading,



and, in particular, path renewal, through new technology development, new business models and organizational innovation. It also comprises mechanisms of related and unrelated diversification by drawing on existing competences and knowledge, and by exploring new unrelated knowledge combinations (Asheim et al., 2019), here by shaping new linkages between industries along the value chain. Transformative change, however, adds the necessity to establish new sociotechnical alignments, both within and across regional boundaries. These alignments target niche-regime interactions and involve amongst others aspects such as societal change, altered demand patterns and regulatory frameworks as well as changes in infrastructures.

## 5. Conclusions

This paper has elucidated transformative change of RIS and the potentials and limitations of regional innovation policy to address innovation geared towards societal challenges. We have developed a theoretical framework complementing RIS with insights from sociotechnical transitions, in which transformative change is explained and theorized in the context of sociotechnical regimes and niches.

The findings suggest a policy-shift away from knowledge creation and recombination between firms and the knowledge infrastructure of the RIS. Transformative change requires a broader view (e.g. Geels, 2002), emphasizing the embeddedness of RIS into a larger sociotechnical context. Policy approaches, therefore, require a perspective on both the extent to which RIS have spaces in which regime-based selection pressures can be moderated, and the extent to which regional actors can favourably influence the RIS-external mainstream selection environment.

Transformative change is strongly related to overall industry – and societal – transformation, implying that sustainable regional development occurs in tandem with sustainable development of the entire region (Houghton & Morgan, 2008; Truffer & Coenen, 2012). The chemicals industry, a heavily polluting, basic materials industry, has a crucial role to play in this process. These results also provide a new perspective on systemic regional innovation and innovation policies. The selection environment of RIS shifts away from related variety towards increasingly connecting different industries and actors along the value chain, that is, new linkages between seemingly unrelated industries. Organizational thickness is only favourable if organizational structures adapt to the new transformative change requirements. Not all regions with organizational thickness and industrial variety will be eager to experiment and transform. Here, the capacity of RIS to induce institutional change is crucial. This calls for a stronger consideration of the ability to change institutional context conditions when addressing the variety creation environment of a RIS.

Regarding policy implications, a shift towards fostering learning processes about new socio-cultural values, sharing expectations about future markets, and building networks along extended value chains through vision-led development seems reasonable. Such alignment of industry-spanning activities is likely to be achieved and maintained with an experimentally open, trust-based innovation climate. Some actions crucial for transformative change (e.g. shaping larger markets, creating new business models, providing risk capital, building infrastructures) are clearly vulnerable to regional implementation limits. Thus, regional policy should also actively engage in policy learning at the supraregional levels.



These findings encourage a variety of future research avenues. Opportunities to initiate and maintain transformation are likely to vary across regions. While this paper has focused on a core region, further empirical studies to apply this understanding of transformative change and green industry development to different region types will be needed (Grillitsch & Hansen, 2019). Further engagement will also be needed to determine the favourable combinations of regional industries for advancing transformative change. Our findings contribute a clearer understanding of the mechanisms behind institutional and organizational change during regional evolution. This invites further research on the specific roles of actors, for example, multinational firms, in contributing to, or impeding, transformation. The findings also highlight the crucial role of regional authorities in changing capacities and competences in transformative regional industrial change, which requires additional attention.

## Note

1. Acknowledging these types of problems generally leads to facing a high level of uncertainty in terms of how they can be addressed (Coenen, Hansen et al., 2015; Bugge, Hansen, & Klitkou, 2016).

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