1 Aim of the contribution

The vision of a bioeconomy calls for a radical shift in current approaches to production, consumption, processing, storage, recycling and disposal of biological resources (Georgescu-Roegen 1971, 1975; OECD 2009; Leadbeater 2013; Schot & Kanger 2016; Vivien et al. 2019). The concept envisages fossil carbon consumption to become increasingly replaced by renewable alternatives. A cascaded usage of biological matter is required in view of planetary boundaries. Therefore, European STI policy for the bioeconomy stimulates intensified actors' collaboration across sectors and divers branches of industry. However, outcomes appear to be rather limited. Against this background, we aim to characterise different groups of bioeconomy actors along with the external factors of influence they perceive. We will highlight those innovation system (IS) components and parameters that are identified from within two European bioclusters to impact the innovation capability and opportunities of entrepreneurs. This analysis allows for new insight into IS dynamics. Results aim to support STI policy for the emergent bioeconomy and SDG attainment.

2 Background & Rationale

Basing itself on Schumpeterian and evolutionary perspectives, IS theory (Freeman 1988, Lundvall 1992; Nelson & Rosenberg 1993) focused upon organisations, institutions and socio-economic structures as components of the systems. Organisations were characterised as the players or actors, while institutions were conceived as the rules of the game (Edquist 2011). In another strand of the scientific IS discussion, it was argued that an IS should be defined in terms of what it does – namely: its functions (McKelvey 1997; Rickne 2000; Bergek & Jacobsson 2003; Edquist 2004). This latter approach was found helpful for the justification of policy interventions in view of transitions (Farla et al. 2012; Markard, Hekkert & Jacobsson 2015).

Bioeconomy promotion is an example of mission-oriented STI policy centred on R&D and cross-industry interaction (Mazzucato 2016; EC 2018). However, IS theory derived from static comparison does not have much guidance to offer for STI policy (e.g. Kuhlmann, Shapira & Smits 2010). It is widely accepted that the insufficiency or rigidity of a critical component may block or slow down the performance of the entire dynamic system (Boekholt 2010). Still, feedback loops among components of innovation systems and interdependencies among different types of innovation (systems) were barely addressed in research so far (Gallagher 2012; Meurer, Rupietta & Backes-Gellner 2015). Most importantly, both IS models have long since been criticised for scant attention paid to the IS micro level and human agency. The perspective is gaining momentum that theory has to incorporate how actors themselves experience and contribute to the enactment of complex processes like innovation and the creation of new trajectories (Sotarauta 2017; Upham et al. 2018). Against this background this contribution asks: Which IS components do bioeconomy actors from different industries regard as prominent barriers or potential drivers of their innovation capacity and opportunities? With the assumption that perceptions guide agency, this is a first step towards improved understanding of system dynamics.

3 Analytical Framework

Established institutions, actors' constellations and resulting power relations in specific networks constitute innovation incentives, hurdles or opportunities to individual actors (Edquist 1997; Weber & Glynn 2006). The differentiation of innovation 'willingness', 'capacity' and 'opportunities' allows for a more fine-grained analysis of agency interacting with specific IS properties. Innovation willingness is caused by a multitude of factors from actor-internal to socio-cultural determinants. At specific occasions, it is documented by actors' involvement in R&D projects. Actor-internal capabilities consist of competencies and resources. Specific types of innovation endeavours in specific industries and countries were found to also call for specific capability profiles (e.g. Hamel 2003; Assink 2006; Mueller, Rosenbusch & Bausch 2013). The enactment of competencies is often tied to specific resources, which might be physical, financial, human or social. These include externally co-determined rights and obligations that are tight to the roles and the social positions of actors

(Abdelnour, Hasselbladh & Kallinikos 2017). An actors' evaluation of own innovation capabilities is not independent from the shape and extend of perceived innovation opportunities (called 'opportunity spaces' by Grillitsch & Sotarauta 2018). However, the evaluation of the desirability and feasibility of successful innovation by motivated actors is assumed to be the crucial determinant of their (individual or collective) innovation behaviour and agency.

The different structural elements of an IS can be studied in regional, sectoral and national IS. The intersection of sectoral, regional, and technical IS is represented by bioclusters (Hermans 2018). Thus, a multitude of intertwined institutions and associated organisational structures are expected to have a bearing on the actors' perception of opportunities. There is also an impact on the actors' capabilities as context conditions shape pathways to gain legitimacy for new undertakings and secure the necessary resources (Suchman 1995; Hannibal 2016; Geels et al. 2017). Institutions and networks affect an actors' actual or perceived room for manoeuvre within an IS and shape her 'lived experience'.

4 Methodology

There is a small number of European countries that have a bioeconomy strategy, formed an advisory board, assigned one or serveral ministries with strategy implementation and launched dedicated R&D programmes (Langeveld 2015). Germany and The Netherlands are early adopters of comprehensive bioeconomy strategies (Dietz et al. 2018) and comparatively old biocluster initiatives could be identified for the study. Qualitative data have been collected through in-depth, semi-structured interviews in one German (N=35) and one Dutch (N= 21) biocluster. Interviewees were asked about strengths and weaknesses of context conditions at local, regional, national and international levels. The reasoning behind the notion of 'relevance' of perceived context conditions was explored regarding own innovation capability and opportunities. Recorded interviews were transcribed and coded for a differentiation of micro, macro and international IS levels as well as the impact categories. The commercial actors' innovation capacity as well as their perception of SIS strengths and weaknesses was expected to be strongly influenced by their size and age. These characteristics are commonly taken to guide research into the impact of the socio-economic positions or the 'power' of actors. Therefore, it was decided to also segregate actor statements accordingly. In addition, the institutional logics' perspective has been adopted (Friedland & Alford 1991, Thornton & Ocasio 1999, 2008; Lounsbury et al. 2003; Koene & Ansari 2013). Actors under market, public (hierarchical), semi-public or collective governance are bound to perceive different problems and solutions.

5 Results

Results to be presented reveal innovation barriers and drivers of agency in the bioeconomy. Alignment to spatial and sectoral IS (SIS, RIS und NIS) allows for

a. a detailed characterisation of the context constellations perceived as relevant for specific bioeconomy actors' innovation capabilities and opportunities;
b. a discussion of the relevance of place-specifics and particular structural components for more or less powerful actors;
c. a bottom-up evaluation of STI policy.

These results form the basis of justified recommendations for the governance of bioeconomy-related STI promotional schemes (regional/national policy shapers).

6 Discussion

First bioeconomy-focussed research efforts have investigated the presence of actors and effectiveness of STI policies (e.g. Ehrenfeld & Kropfhäußer 2017; Hüsing et al. 2017) or applied IS theory to detect systemic weaknesses (Purkus et al. 2017). In addition, broad influencing factors were identified in efforts to generate development scenarios or guiding principles for the management of technology transfer and innovation processes (Hagemann et al. 2016; Van Lancker, Wauters & Van Huylenbroeck

2016; Borge & Bröring 2017). Therefore, the results of this study on how actors themselves experience their context conditions will not only be reflected with respect to IS theory but also in light of specific insight on innovation in the emerging bioeconomy.

Bioeconomy promotion is an example of mission-oriented STI policy centred on R&D and cross-industry interaction. According to the European Commission's guide for this type of policy (EC 2018), ambitious objectives will ensure that researchers and innovators are challenged to deliver what would otherwise not be attempted ('additionality' in research). Most interviews from the German cluster provided clear evidence of additionality for the R&D projects implemented - not only for start-ups and SMEs but also for large and/or multinational companies. According to the EU, mission-oriented STI policy should also frame objectives in such a way that endeavors are "on the one hand high-risk but also realistically feasible, at least in theory, within the given time period" (EC 2018: 14). Against this background, first results of this study point to considerable over-optimism of STI policy shapers. They also indicate a mismatch of STI instruments employed on the one hand, the needs and capabilities of bioeconomy actors on the other hand.

The conditions established for bioeconomy actors in the German and Dutch NIS differ considerably. Most results and conclusions remain to be verified for other European countries. The study was restricted to the sectors of building materials, plastic and green chemistry industries. Other bioeconomy sectors (recycling of biomass, bioenergy, textiles, etc.) may reveal differing actors' perceptions and deserve further attention. A subsequent analysis of actors' coalition building and leverage effectuation in public discourse arenas is planned. This serves to broaden the understanding of IS dynamics under consideration of actors' advocacy coalition building activities.

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