Developing a Knowledge-based Bioeconomy: A Network Analysis of the Norwegian Food Processing Industry

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The bioeconomy has recently been promoted to help to address such major global challenges as climate change, resource scarcity, and food security. The transition towards the bioeconomy necessitates a shift in production and consumption from fossil-based to a more sustainable mode—bio-based, which requires a strong commitment and an active engagement from all stakeholders in the economy (European Commission 2012). Industry plays a crucial role in the economy, acting as the provider of products and services. The pertaining question is how it can continue to contribute to economic growth with the least environmental impact. An important vision of the bioeconomy is "bio-resource" (Bugge et al. 2016), which pushes the need for using bio-based materials and resources more effectively and efficiently. To do so, industrial firms need to deviate from the "business as usual" perspective, which requires new knowledge and skills to be able to develop sustainable/environmental innovations.

To foster the bioeconomy, new and relevant knowledge is critically needed, especially for production firms in a considered low-tech industry like food. The food industry is often criticized for wasting raw materials along the value chain (European Commission 2014); especially when those resources can be utilized and give high added-value in many applications and products through bioprocessing technologies (Henchion et al. 2016, Toldrá et al. 2016). To develop new knowledge and skills for such beneficial applications and products, food firms often participate in research networks and funding programs. **What types of knowledge they need to acquire, and with whom they collaborate**? Knowledge bases literature argue that the food industry is more inclined to the synthetic knowledge base (Martin and Moodysson 2013); however there is a lack of empirical studies in this aspect, which is, in turn, important and relevant for both the industry and policymaking.

In light of this, the paper looks into a Norwegian funding program—BIONÆR (Sustainable Innovation in Food and Bio-based Industries) that strongly promotes sustainability aspect in the food and other bio-based industries, and investigate the following research question: *How does the Norwegian food industry develop new knowledge for sustainable innovations for the bioeconomy?* To

answer this question, the paper studies the program's research projects, participants, and the relationships between them. The paper explores what actors play a key role in the knowledge development and transfer in the research network as well as what types of knowledge Norwegian food firms acquire through the research collaboration. The theoretical approach of the paper draws on the knowledge bases view (Asheim and Coenen 2005, Boschma 2018) and the concept of university-industry (U–I) collaboration (Bishop et al. 2011, Fitjar and Gjelsvik 2018). By applying social network analysis (SNA) method, the paper scrutinizes the relationships and interactions between the actors, and their structural interconnections in the knowledge network. The main input data for this study is 315 research projects from the BIONÆR program. To triangulate the data, semi-structured interviews are conducted with selected projects' coordinators and participating firms. Documents, scientific outcomes, and reports of the projects are complementarily used for the analysis.

The paper contributes to the identification of sub-categories of the knowledge bases, highlights the importance of U–I collaboration in developing new knowledge, and notes the role of analytical knowledge for food processing firms in the context of the bioeconomy.

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