

Using sequence analysis to uncover the spatio-temporal emergence of bioeconomy innovations

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The transition from a fossil-based economy to a circular bioeconomy, underscored by the need for sustainable production and consumption, is increasingly reliant on novel biobased technologies (Aguilar et al., 2018; Befort, 2023; Bugge et al., 2016). However, the geographical distribution of these bio-innovations is anticipated to be uneven, presenting new challenges for regional development and necessitating nuanced policy actions (Abbasiharofteh & Broekel, 2020; Fischer et al., 2024). However, the existing literature on the geography of bio-innovation is currently limited, especially in empirical evidence regarding the spatial distribution of novel biobased technologies and how these geographical patterns might have changed over time. This limitation is largely due to the inadequacy of traditional patent classifications in tracking biobased technologies (Losacker et al., 2023; Wydra, 2020). Against this background, our paper sets out to achieve two main objectives. First, we develop a novel methodology for identifying biobased technologies in global patent data. That is to say, we utilize modern natural language processing techniques for the identification of biobased technologies from patent abstracts, which offers a more refined approach than conventional methods based on keywords or simplified classifications (Kriesch, 2023). Second, using this novel data, we analyze the geography of bio-innovation over time. In more detail, we utilize geocoded patent data sourced from De Rassenfosse (2019), apply our identification approach to these data, and aggregate the data at the level of more than one thousand functional urban areas, in accordance with the definitions provided by the OECD (following e.g., Broekel et al., 2023; Fritsch & Wyrwich, 2021). For these specified regions, we subsequently examine the temporal evolution of innovation activities in the bioeconomy for a time span of more than twenty years. To do this, we apply sequence analysis methods, an empirical tool that has been rarely used in the fields of economic geography and regional science so far (for exceptions see Hansmeier & Losacker, 2023; Kuebart, 2022). Sequence analysis enables us to examine regional trajectories in biobased innovation. Additionally, it facilitates the comparison of these trajectories across different regions. This approach ultimately allows for the clustering of diverse regional paths towards a bioeconomy, enhancing our understanding of their unique characteristics and developments. The findings of this paper contribute significantly to the understanding of the global geography of bio-innovation. Our research is particularly relevant for policymakers, given the increasing implementation of bioeconomy strategies by countries and regions worldwide (Proestou et al., 2023).

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