

Exploring Twin Transition pathways with an FsQCA approach

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Horizon Europe (2021 – 2027), the EU's key funding program for research and innovation (€95.5 billion), aims to tackle main global challenges, increase competitiveness, strengthen collaboration in the field of research and innovation, promote open science policy, and spread excellence. Among other goals, it actively promotes the twin green and digital transition (European Commission, 2021). This transition is characterized by inherent complexity, stemming from the interactions among heterogeneous actors operating within social, economic, and ecological frameworks (Montresor & Vezzani, 2022). Analyzing these dynamics through a complexity approach is essential to understanding the unpredictable and non-linear nature of regional development (Meekes et al., 2017) and path dependency (Cooke et al., 2012).

Conceptually to grasp transition pathways, the framework of new regional path development provides valuable insights (Grillitsch et al., 2018; Tripl et al., 2020). Indeed, it captures the multifaceted influences shaping regional growth and technological evolution, offering a structured approach to analyze and guide the challenging integration of green and digital strategies within regional contexts. Traditionally, academic work on regional path development tends to focus on path-dependent models of regional industrial development (Martin & Sunley, 2006). This body of literature emphasizes that preexisting industrial structures and institutional context critically shape the regional environment, influencing both ongoing economic and innovation activities and the emergence of new ones, thereby reinforcing the long-term persistence of regional industrial setups.

Despite the growing body of conceptual and empirical work has enriched our understanding of new path development (Grillitsch et al., 2018; Hassink et al., 2019; Isaksen et al., 2018; Tripl et al., 2018, 2020), a more fine-grained conceptualization of new path development has been developed, combining evolutionary economic geography with insights from regional and technological innovation systems, socio-technical transitions, global production, innovation networks, and sociological perspectives (Bürscher et al., 2024; Hassink et al., 2019). This approach has helped to point out other forms of explanatory paths, i.e. path extension, path creation, path importation, path upgrading, path branching, and path diversification.

To the best of our knowledge, this conceptualization has not been sufficiently validated to assess its effectiveness in diverse regional contexts. To address this gap, we conducted a literature review to identify studies that present a regional case study analyzed through the framework of regional path development. Subsequently, the thirty selected studies were categorized into six distinct categories based on their explanatory path, allowing for the extraction of key factors shaping regional development. Thus, we applied fuzzy-set qualitative comparative analysis (FsQCA) in order to define different pathways of the twin transition across European regions. This methodological approach is well-suited for analyzing complex causal configurations,

addressing equifinality and multicausality (Rihoux & Ragin, 2012) of twin transition, overcoming limitations of traditional linear models (Ragin, 2014).

We aim to identify distinct patterns among the different types of path development and systematically assess the specific conditions under which regional twin transitions occur.

The contribution of our work is twofold. First of all, it improves the theoretical underpinning of the pathway definition. We identify concrete regional case studies that support the conceptualisation of new regional path development in a more fine-grained view. Second, by applying FsQCA, this study seeks to elucidate how different development path shape distinct twin transition pathways, thereby generating valuable insights for policymakers.

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