Regional Pathways to Twin Transitions: Regional Capabilities, Technological Diversification, and Policy Implications for Green and Digital Convergence in Europe.

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Extended Abstract

To address interconnected social, economic, and environmental challenges, the European Commission has introduced the Twin Transitions strategy, which integrates the Digital Strategy with the Green Deal. This initiative aims to foster economic growth, boost competitiveness, and accelerate progress toward sustainability goals. The Commission underscores the importance of ensuring that all European regions benefit from the strategy. However, regional disparities in the diversification of innovation portfolios may hinder some regions' ability to implement it effectively (Bachtrögler-Unger et al., 2023). Thus, the inquiry is how digital, green, and twin technologies are developing across European regions, and whether regions with established specialisations in green or digital technologies have the potential to also advance twin technologies.

Using the framework of regional diversification and relatedness (Balland et al., 2019; Pinheiro et al., 2022; Rigby et al., 2022), the existing scientific and invention landscape for green and digital technologies is mapped across European regions. The analysis uses patents as indicators of invention and scientific publication as a proxy of scientific knowledge production. The relatedness framework enables the identification of regional capabilities and the potential to integrate green and digital technologies (Bachtrögler-Unger et al., 2023). Regions highly specialised in green and digital technologies are highlighted alongside regions where twin technologies are likely to emerge.

The analyses focus on identifying common building blocks in the patenting and publishing of green and digital technologies. Co-citation networks are used to identify cognitive linkages between green and digital technologies, enabling the identification of twin

scientific publications and patents. Following this, digital, green, and twin capabilities in publishing and patenting are mapped and compared against social, economic, and environmental indicators, including GDP, unemployment rates, and greenhouse gas emissions. This comparison provides a contextual framework for interpreting the results. Additionally, the cross-collaboration between regions is evaluated to identify regions with country-level or European-level collaboration. Lastly, the analysis incorporates temporal dynamics and mapping regional trajectories. For instance, regions transitioning from green specialization to twin specialisation (green and digital) are identified, as well as regions that attempted to develop green and digital capabilities but did not succeed.

The findings reveal that many European regions have low green and digital capabilities for technological diversification. These regions often face difficulties in establishing social networks with others and lack the invention capabilities required to develop green and digital innovations successfully. In contrast, regions with capabilities in either green or digital technologies exhibit distinct technological trajectories and different starting points for implementing the twin transitions agenda. Notably, some regions are advancing both digital and green transitions; those with strong capabilities for twin transitions are frequently linked to robust economic development and well-established innovation ecosystems, but in many cases, with high greenhouse emissions. Despite the co-location of digital and green technologies in certain regions, their convergence within new technological trajectories is still in its early stages. In this direction, the temporal analysis reveals that digital regions building new capabilities in the green domains often struggle and can lose strategic advantage in developing digital trajectories. Conversely, regions focusing on the green trajectory have been more successful in building diversification capabilities in the digital domain. This success can be attributed to Europe's favourable institutional landscape for green innovation.

The findings of our study emphasise that regions have distinct starting points in advancing the twin transitions agenda. Policymakers must, therefore, develop region-specific strategies to address the varying levels of regional specialisation in green and digital capabilities across Europe. Regions focusing on green innovation typically benefit

from a stable institutional landscape, making them well-suited as starting points for integrating digital technologies and advancing the twin transition. In contrast, digital regions may require additional policy support and enhanced cross-regional collaboration to fully develop their digital trajectory and redirect their outcomes toward the green sector. Regions with low diversification capabilities could benefit from initially focusing on green transitions to build foundational capabilities. Meanwhile, twin regions are strategically positioned to act as demonstrators and hubs for driving and leveraging the twin transition.

Reference

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