Structural change and convergence clubs using UMAP technique

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The structural change was the main source to explain the convergence process that took place in the European regions after the World War II. This process halted or even ceased during the 1980's and since the Great Recession a new phase of divergence started. The new pattern of divergence has rekindled interest on the potential role that the structural change could have in this process. This time divergence comes from a selected group of wealthiest regions moving away from the rest while most of the regions tend to converge or to get trap in the middle (Gomez-Tello et al., 2020; Ianmarino et al., 2019) or, more worrying, to lag behind in very low-income levels. While the number of regions getting trapped in low income growth soars (Diemer et al., 2022), regional disparities and social unrest unleash political polarization across Europe (Dijkstra et al. 2020; Sielker et al, 2021; Rodriguez-Pose et al., 2024). The success of the most prosperous regions seems to be linked to the start of a new structural change process. This time the dynamism comes from the specialization in high-tech manufacturing or knowledge-intensive services (Camagni et al., 2022; Valentini et al., 2023; Cutrini et al., 2023; Carullo et al., 2025).

Then convergence has abandoned universality that characterized the second half of the 20th century and has become in a selective question linked to specific groups of regions. This fact has rekindled the old question of the convergence clubs (Annoni et al., 2019; Capello and Lenzi, 2021). But this time the analysis rely on the use of new and more sophisticated criteria and techniques to identify the convergence clubs (Postiglione et al., 2010; Bartkowska and Riedl, 2012; Fischer and LeSage, 2015).

In this research we propose the use of a new dimensionality-reduction technique to identify convergence clubs taking into account a broader set of regional characteristics, among them

industry mix at a 10 level NACE sectors. Specifically, we propose the use of the Uniform Manifold Approximation and Projection (UMAP) method, one of the state-of-the-art methods for dimensionality reduction and data visualization. It was developed by McInnes, Healy and Melville (2018), on the basis of a theoretical framework derived from the Riemannian geometry and algebraic topology. As compared with other dimension reduction techniques, the UMAP has no computational restrictions on embedding dimensions, making it viable as a general purpose dimension reduction technique for machine learning and data clustering. Its main target is to provide an algorithm that is both scalable to massive data and able to cope with the diversity of data available. It preserves the global structure of the dataset giving an image that preserves almost 100% of the total variance in the dataset.

We take data from ARDECO database (Annual Regional Database of the European Commission's Directorate General for Regional and Urban Policy) which was developed by Cambridge Econometrics and maintained by the Joint Research Centre. This database provides series disaggregated by industry at 10 NACE sectors.

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