The Dynamics of Innovation Activity in Europe over the Early 21st Century: A Tale of Concentration and Transformation

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We examine the dynamics of regional innovation activity within Europe in the early 21st century. Patent data show that regions in Eastern and Southern Europe lag far behind their Western European counterparts. This gap is closing very slowly over time. Such a slow convergence in innovation activity may be largely rooted in the socialist legacy and the sudden transformation of political and economic systems that occurred after the demise of socialism. However, such explanations do not hold for other lagging regions, particularly those in Southern Europe. Employing a rather novel approach, we use ranks of regions within Europe and analyze changes in ranks. This allows us to investigate regions that have risen strongly in the past 20 years ('leapfroggers'). Rural regions with low population density and an under-established manufacturing sector seem to contribute to the persistence of low levels of innovation activity.

Keywords: innovation, patents, transformation, convergence, Eastern Europe

JEL Classification: O31, O52, P27

1. Introduction

We investigate the evolution of regional innovation activity in European regions from 2000 to 2020. Patent application data reveal persistent gaps, with Eastern and Southern Europe trailing behind their Western counterparts. We find that

innovation activity in these lagging regions is catching up, albeit quite slowly. This persistence of regional innovation disparities raises questions regarding the underlying drivers of slow growth in some regions. While the legacy of socialism and the rapid transformation of political and economic systems may explain the stagnation in Eastern Europe, similar factors do not fully account for Southern Europe's lagging performance.

2. Regional development of innovation activity between 2000 and 2020

Based on the OECD RegPat database we use patent applications as a proxy for innovation activity. Our study covers patent applications to the European Patent Office at the regional NUTS 2 level from 2000 to 2020 for all European countries as well as Norway, Switzerland and the United Kingdom. We exclude the 1990s to avoid transition noise in post-socialist countries and ensure data reliability by omitting post-2020 patents due to reporting delays and potential COVID-19 effects.
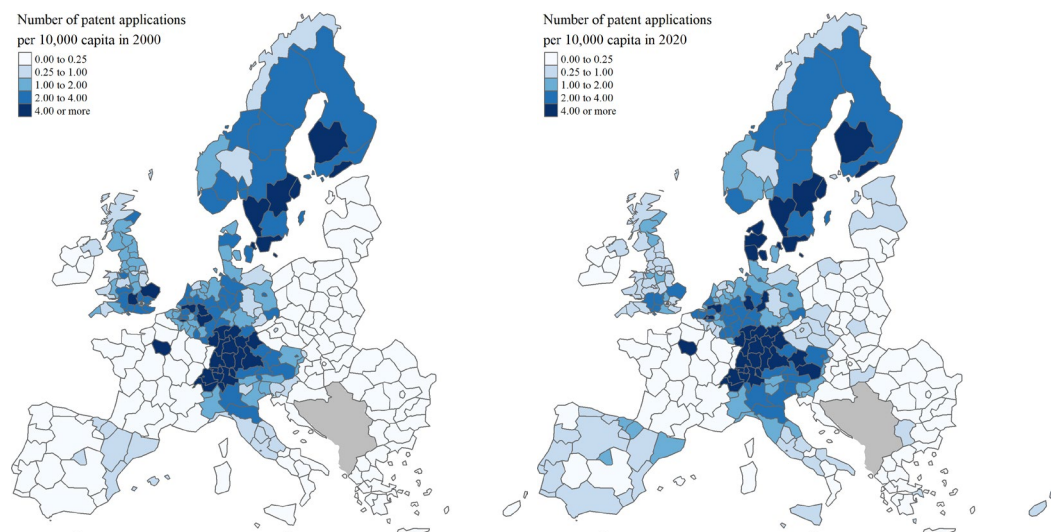

Figure 1: *Spatial distribution of patent applications per 10,000 capita by NUTS region in 2000 and 2020. Source: OECD RegPat Data (OECD 2016)*

Figure 1 illustrates the number of patent applications per 10,000 capita in the years 2000 and 2020. It highlights persistent disparities between regions. In 2000, Eastern European regions averaged only 0.36 applications annually compared to 2.39 for the rest of Europe, with similar figures for Southern Europe. While the distribution of patent applications has shifted towards higher

values over time, convergence remains slow, with lagging regions catching up only gradually to their Western counterparts.

3. Convergence of regional innovation activity

To assess convergence, we estimate absolute and conditional ß-convergence using patent applications per 10,000 capita. Our results indicate slow but statistically significant absolute ß-convergence, with lagging regions catching up at a modest pace. The implied half-life for eliminating half of the given disparities exceeds 500 years. Conditional ß-convergence – accounting for regional factors like GDP per capita, population density, and tertiary education – suggests a slightly faster process. Eastern European regions exhibit the highest growth rates, aligning with a strong catching-up trend. Additionally, we examine σ-convergence by measuring changes in the dispersion of patent applications over time. We find a gradual reduction in the variance of patenting activity across regions between 2000 and 2020, indicating that the observed ß-convergence leads to a decrease in disparities among European regions over time.

The formation of "convergence clubs" – where regions with similar innovation dynamics evolve together – suggests that convergence is uneven, with some regions trapped in low-innovation cycles while others progress rapidly. These findings highlight the need for targeted policies to enhance knowledge spillovers, R&D investments, and regional absorptive capacities to accelerate convergence.

4. Rank mobility and leapfroggers

To complement this traditional convergence analysis, we employ a novel League Table approach, ranking regions based on patent applications per capita. This method offers a straightforward comparison of regional performance over time, making it an effective tool for policymakers. League Tables highlight individual regional progress and setbacks, facilitating the identification "leapfroggers" (rapidly advancing regions) and "plungers" (rapidly declining regions) (cf. Potter et al. 2023). Figure 2 plots the rank of each region in 2000 against their rank in 2020, where Rank 1 represents the highest number of patent

applications per 10,000 capita while rank 289 represents the lowest. The close distribution around the diagonal illustrates how stable ranks are over time. Indeed, a Spearman rank correlation coefficient of 0.95 underlines this observation. Especially among the very top and bottom ranks there is very little mobility; while the middle ranks show more movement.
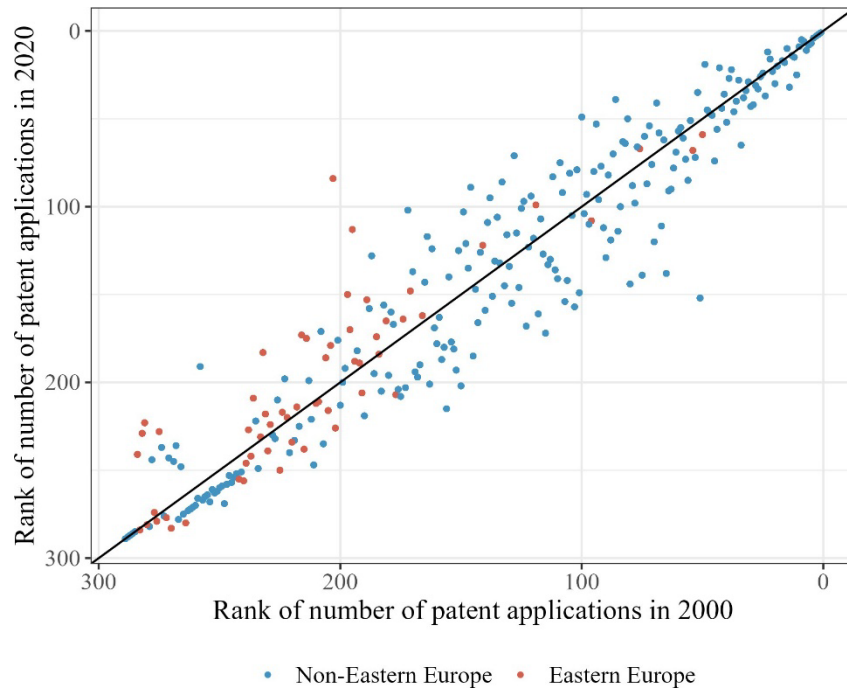

Figure 2: *Rank Mobility in patent applications per 10,000 capita between* 2000 and 2020.

We calculate a Rank Mobility Index (RMI) for each region, which quantifies rank changes over time. Figure 3 shows the RMI of the European regions, where positive RMI represents strong upward mobility and vice versa. Our findings reveal that Eastern European regions exhibit strong upward mobility, aligning with the hypothesis that lagging regions grow at higher rates. In contrast, Western and Northern European regions are predominantly plungers.

Linear regressions indicate that population density and quality of government are strong predictors of regional innovation success. Rural regions with low population density and an underdeveloped manufacturing sector tend to exhibit persistently low levels of innovation activity. The role of geographic proximity to highly innovative regions (e.g., the "Blue Banana" corridor) also appears significant.
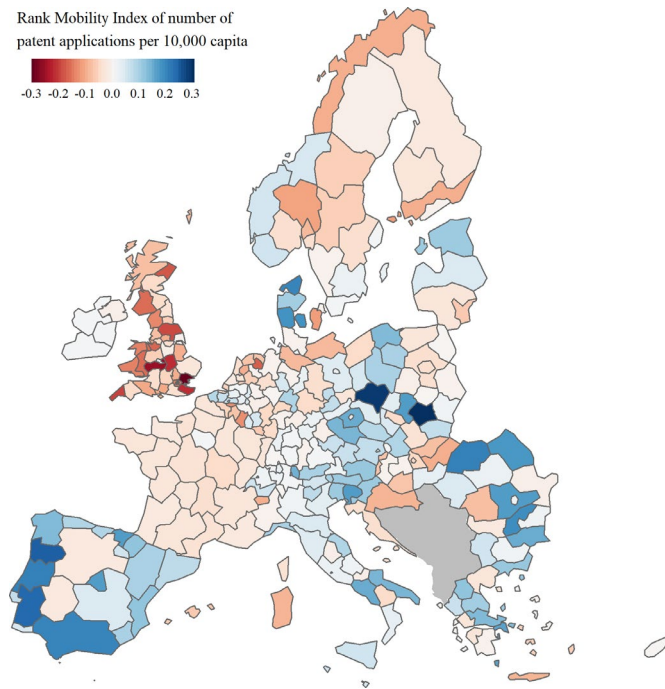
Figure 3: *Rank Mobility Index of patent applications per 10,000 capita between* 2000 and 2020

5. Conclusion

Our findings underscore the slow pace of convergence in regional innovation activity across Europe. These results highlight that while some regions demonstrate remarkable progress, others remain locked in low-innovation traps, necessitating targeted regional innovation policies.

References

OECD REG Database - Codebook (2016).

Potter, J., Qian, H., Fritsch, M., Storey, D., & Fotopoulos, G. (2023). L*eapfrogging and plunging in regional entrepreneurship performance in the United States, with European comparisons.* Paris: OECD publishing (OECD SME and Entrepreneurship Papers No. 44). https://dx.doi.org/10.1787/bc031b11-en