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Knowledge production function and proximities. Evidence from spatial regression models for the European regions

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1. OBJECTIVES

It is widely recognised that the capacity of a region to generate, transmit and acquire knowledge and innovation depends on a multifaceted set of factors: investment in R&D, work force experience, education and training, collaboration networks, technology transfer mechanisms, researchers' and workers' mobility. In particular, the literature has distinguished between the creation of new ideas and inventions and the absorption of innovations generated in other regions. In this perspective, the general object of the paper is to analyse how internal and external factors interact in determining the technological performance of the European territories. More specifically, we investigate to what extent the regional inventive activity depends on intra-regional characteristics (mainly R&D expenditure and human capital) and on regions' ability to absorb inter-regional knowledge spillovers channelled and diffused by different types of proximity, namely: geographical, institutional, technological, social and organizational. The paper, therefore, addresses the following main research questions:

1) what is the balance of internal and external factors in shaping regional innovative performance?
2) what kind of connections are most effective in driving knowledge spillovers across regions?
3) Are these connections complementary or substitute?
4) What lessons can be gained from such results to design more effective innovation policies both for EU and ENC regions?

2. SCIENTIFIC METHOD

The role of internal and external factors in enhancing regional innovation capacity are investigated by applying spatial econometric techniques to a Knowledge Production Function (KPF) model. With respect to its traditional formulation, this is augmented with extra-regional factors, mediated by different kinds of proximity and networks (institutional, geographical,

technological, social and organizational), which are expected to enhance a region's innovative activity. Our analysis is based on an ample dataset referring to 276 regions in 29 countries (EU27 plus Norway and Switzerland) over the last decade. The particular richness of the information required for the implementation of our econometric analysis denies the possibility to extend our sample to regions in the European Neighbouring Countries. Nevertheless, results are sufficiently broad to allow for a generalisation of some far reaching conclusions.

3. MAIN RESULTS

Four main results emerge from our empirical analysis.

First, in all models considered human capital is more innovation enhancing than R&D: its total effect, which includes knowledge spillovers transmitted by proximate regions, is on average six times higher than the one associated with R&D expenditure.

Second, spillover effects are significant for human capital in all models considered. This original finding indicates that it is the endowment of skilled and well-educated people which ensures that knowledge flowing from external sources can be effectively absorbed and transformed into new ideas and innovations, while high levels of R&D do not seem to grant the same desirable result.

Third, all proximity dimensions considered are found to play a significant role in channelling knowledge flows. Comparing the strength of regional association captured by the different "closeness" dimensions, the technological one ranks first, followed by the geographical one; the weakest relations are found for the social and organizational networks.

Fourth, we find evidence of important complementarities among the different proximities. This turns out to be rather relevant in all the cases in which the technological connectivity is involved, signalling that a common cognitive base appears to be a crucial element for conveying knowledge across regions.

Overall, the analysis presented in this paper confirms the great degree of complexity of the knowledge creation and diffusion process in the highly integrated European economic context. Our findings highlight the prominent role played by human capital in driving knowledge transfers and innovation creation and the importance of extending and strengthening regional interconnectivity along both spatial and a-spatial dimensions

4. POLICY VALUE-ADDED

Our analysis offers some relevant and original empirical findings which allow for a better understanding of the processes of knowledge creation and diffusion across Europe and ENC.

- The first general policy advice is that regions and countries still need to focus on actions aimed at increasing the endowments of well-educated labour force, given their strong and pervasive role in determining both the internal creation and the external absorption of knowledge. The impact of graduates on innovation activities is much stronger than formal R&D expenditures.
- The second policy implication derives from the existence of several channels of interregional spillovers and externalities, which calls for a coordinated strategy able to attain the optimal social outcome with differentiated interventions. It is increasingly clear that there is no "one size fits all" policy and that regions need to set different targets to be achieved with diverse instruments.
- Third, the presence of knowledge flows along the technological space implies that regions should try to create a common knowledge base and specific industrial platforms to maximize the absorptive capacity. Policies should support the formation of dense specialised networks among regional innovation systems which go beyond the geographical clusters.

- The empirical relevance of institutional proximity implies that public may be crucial for avoiding inefficient behaviours due to lack of trust among agents in different regions. Thus, a process of effective homogenization of norms, procedures and standards for the whole of Europe and beyond is required to help the creation of a real institutional closeness among all European areas.
- Externalities arising from social and organizational interregional relations require policies designed specifically to sustain those areas where the absence or the shortage of either social or organizational capital may hamper the creation of such networks.
- This interpretative scenario is crucial for regions in ENC since it enlarges the potential basin of knowledge externalities which may help their technological catching up with respect to advanced regions in the European Union. This basin goes beyond the mere geographical one to include the technological, the institutional, the social and the organizational dimensions.
- There is a clear potential for catching up of laggard and peripheral ENC areas as it has happened in the recent years for new entrant regions of Eastern Europe. Such a goal clearly entails enhanced consistency of national and regional strategies. Strategies which recognise that each region innovation potential is unique because of different geographical, cognitive, social, institutional and organizational structures and networks, and each region requires specific local platform policies based on differentiated knowledge structures.