

From urban agglomeration to regional productivity: Human capital externalities across European regions

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Extended Abstract

The widening of regional disparities in income per capita and labour productivity has become a key issue in the European Union's cohesion agenda. While a handful of metropolitan areas are becoming increasingly dynamic and innovative and creating more high-skilled jobs, many other regions are struggling to sustain long-term productivity growth. Therefore, it is crucial to understand the mechanisms through which agglomeration advantages interact with factor accumulation to explain the persistence and possible amplification of regional disparities.

This paper investigates whether agglomeration economies consistently amplify the impact of human capital on labour productivity growth across European regions. Moving beyond city-level analyses, we examine how urban agglomeration advantages operate at the NUTS-2 regional scale, and how these advantages shape heterogeneous growth trajectories within Europe. Our central hypothesis is that returns to human capital are not uniform across space; rather, they depend on the intensity and configuration of regional agglomeration economies.

The European Union is a particularly relevant setting for this analysis. Despite sharing an institutional framework and placing a strong emphasis on territorial cohesion, European regions remain highly heterogeneous in terms of productive specialisation, demographic dynamics, innovation capacity and long-term growth performance. This challenges the assumption of homogeneous factor returns typically embedded in parametric growth models, calling for empirical approaches capable of capturing spatially differentiated effects.

Our empirical framework is based on the augmented neoclassical growth model developed by Mankiw, Romer and Weil (MRW), which assumes exogenous technological progress and conditional convergence towards region-specific steady states. In this setting, long-run productivity dynamics depend on the accumulation of physical and human capital, as well as on structural characteristics that affect steady-state levels. However, standard cross-sectional or panel parametric estimations impose constant elasticities across space, which can potentially obscure nonlinearities and local growth regimes. To address this limitation, we use a non-parametric estimation strategy based on locally linear least squares (LLS) to estimate a conditional convergence equation for an initial sample of 121 NUTS-2 European regions. The data, which are drawn from BDEURS and EUROSTAT, cover a sufficiently long period to capture medium-term growth dynamics. The LLS approach enables us to examine how the elasticity of labour productivity growth in relation to human capital varies across regions, thus revealing spatial heterogeneity in returns that would remain hidden under a global parametric specification.

Human capital is approximated by the proportion of employment in ICT-intensive sectors among those with a tertiary education (HRSTC), which captures both educational attainment and participation in knowledge-intensive activities. Rather than focusing solely on average effects, we extract region-specific local coefficients from non-

parametric estimation. These coefficients represent the marginal contribution of human capital to productivity growth in each region, given its structural characteristics.

The first stage of the analysis yielded three key findings. Firstly, the average impact of human capital on labour productivity growth is positive and statistically significant, which is consistent with the predictions of the augmented neoclassical model. Secondly, there is substantial heterogeneity in the estimated elasticities across regions. In several territories, particularly those with large metropolitan areas or diverse economic structures, the elasticity is notably higher than the European average. Thirdly, this heterogeneity displays a systematic spatial pattern rather than random dispersion.

To explore the spatial mechanisms underlying differentiated returns, we incorporate the multidimensional agglomeration indices developed in Gómez et al. (2025). The composite index is constructed from five dimensions capturing different aspects of agglomeration: employment density, total population in metropolitan areas (aggregated from NUTS-3 metro-regions to NUTS-2 level), and three location quotients measuring regional specialization in information and communication services, financial services, and professional services. As a result, we distinguish between a total agglomeration index and a spatial agglomeration index capturing clustered high-value patterns across neighbouring regions. We classify regions according to the distribution of the global agglomeration index and compare the average human capital elasticity of highly agglomerated regions (P75) with that of less agglomerated territories (P25). The results show a clear and statistically significant gap between these groups. On average, the elasticity of labour productivity growth with respect to human capital in the top quartile of agglomerated regions is approximately twice as large as in the bottom quartile. This difference remains robust when using the spatial agglomeration index.

These findings suggest that agglomeration economies amplify the growth impact of human capital, but the effect differs depending on the nature of agglomeration. Regions located in the top quartile (P75) of the total agglomeration index include both capital-city regions characterized by very high intrinsic density and specialization, and regions embedded in spatial clusters of agglomeration. However, once the spatial filter is applied, an important distinction emerges. Regions hosting major European metropolitan areas, such as capital cities, rank highly in the total index but tend to score lower in the spatial agglomeration index, since their performance reflects dominant internal characteristics rather than strong similarity with neighbouring regions. In contrast, the regions in the top quartile of the spatial index form clusters of highly agglomerated neighbouring territories. In these spatially integrated systems, complementarities between skilled labour, innovation-oriented service specialisation and interregional economic interaction are reinforced across regional borders. This configuration enhances the diffusion of knowledge, the adoption of technology, and the spillover of productivity beyond the limits of a single urban core.

The impact of human capital on productivity varies across regions. Its impact depends on the territorial structure within which it is embedded. Regions integrated into spatial clusters of agglomeration can translate investments in skills into stronger

productivity gains. In contrast, more isolated regions may face structural constraints that limit these benefits. Consequently, differences in spatial agglomeration may exacerbate performance disparities between clustered cores and less integrated territories.

The second stage of the project is currently underway. In this stage, we will extend the analysis to cover the entire set of NUTS-2 regions in the EU-27. We will use regional macroeconomic indicators from ARDECO and the primary proxies for human capital from EUROSTAT to achieve this. As well as replicating the quantile-based regime comparison (P25, P25–P75 and P75) implemented in the initial sample, where we test for statistically significant differences in the average estimated human capital elasticities across agglomeration regimes, the enlarged EU-27 setting enables us to complement this approach with a second-stage endogenous threshold analysis based on the distribution of the estimated regional gradients.

Specifically, we will examine whether there is a statistically significant breakpoint in the relationship between agglomeration intensity (as measured by PC1 and its spatial component) and the estimated returns to human capital at an unknown level of agglomeration, which will be estimated endogenously. This strategy enables us to distinguish between two potential patterns. Firstly, the data may reveal a discrete regime shift, which would be consistent with the existence of a critical level of agglomeration beyond which human capital elasticities increase markedly. Alternatively, the relationship may be characterised by smooth but systematic heterogeneity, with returns varying progressively along the agglomeration spectrum rather than changing abruptly at a single threshold. In either case, the extended EU-27 analysis will enable us to more precisely assess the structural nature of agglomeration-related differences in human capital returns.

From a policy perspective, the results will have different implications depending on the structural form of the relationship. Identifying a significant endogenous threshold would suggest the existence of a critical mass of agglomeration necessary for human capital investments to generate strong productivity gains. This would call for integrated territorial strategies combining education policies with measures to strengthen spatial connectivity and economic density. Conversely, if the relationship is gradual rather than discontinuous, policy interventions could focus on enhancing regional integration and functional linkages progressively, without needing to surpass a strict structural threshold. Either way, the findings would contribute to the debate on whether human capital acts as a convergent or divergence-enhancing force within the European Union.