

Transformative Dynamics of European Regional Development

Examining the Blue Banana and the Pentagon in Light of Emerging Epiphenomena and Future Perspectives on the Dorsal Axis

Luigi Capoani, Csaba Lakócai, Cristoforo Imbesi

Abstract: The following regional science study investigates the ongoing relevance of the Blue Banana and Pentagon models as accurate representations of the European Economic Core Zone. The analysis aims to provide useful insights into the evolution of the European socio-economic landscape through an empirical examination that questions the applicability of these frameworks, given the progressive emergence of a polycentric model accompanied by an eastward shift of European productive activities. Together with an empirical analysis of two measures of regional competitiveness, the paper employs the case studies of the United Kingdom and Northern Italy to examine the changes in the European socio-political and economic landscapes. This study explores the implications of Brexit and its impact on the competitiveness of both the UK and continental Europe by integrating different metrics, including unemployment rates, productivity trends and the circulation of people. Furthermore, the case of Italy enables for a comparison of six socio-economic indicators between Northern-Italy and the regions of the Economic core, in order to reassess the compliance of the area with the criteria defined by the aforementioned models, after the 2008 financial and economic crisis. In light of this analysis, the need to create adaptive regional models in response to the current dynamism created in Europe is emphasised.

Keyword: Blue Banana, Northern Italy, Brexit.

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1. Introduction

Four decades after their initial conceptualisation, to what extent do the Blue Banana and the Pentagon remain relevant frameworks for the analysis

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of European development patterns? Drawing on their wide recognition in the academic literature and policy discourse, the Blue Banana and the Pentagon remain useful empirical benchmarks, offering an immediate reference for assessing shifts in regional competitiveness. This paper explores the key spatial and economic models of analysis employed in the relevant literature to describe and deepen the understanding of European Regional Development. In particular, we investigate the case studies of the United Kingdom (UK) and Northern Italy as two relevant empirical instances and key drivers of evolving continental dynamics. The decision to focus specifically on the United Kingdom and Northern Italy is guided by both conceptual and empirical considerations. Historically, these two regions constituted the northern and southern ends of the Blue Banana and Pentagon models; in recent years, however, both have experienced unique challenges that affected their position within the European Economic Core Zone. They thus serve as strategic points to evaluate the spatial and conceptual coherence of these frameworks. Furthermore, while substantial research exists on the two frameworks and their development over time, there is no previous literature that has reassessed the relevance of the two spatial models in light of the changing economic positions of the mentioned regions. This study therefore allows an in-depth scrutiny of Europe's shifting economic geography, assessing whether the proposed models remain valid in capturing the complexities of contemporary regional developments.

The United Kingdom has played a pivotal role in the European Regional Development, particularly within the Blue Banana and the Pentagon frameworks, which historically represent the block's monocentric spatial development pattern. However, the withdrawal from the EU following the 2016 referendum had a lasting and far-reaching impact. In regional development terms, the UK constitutes one of the vertices of the Pentagon and the Northern edge of the Blue Banana. Brexit seems to have disrupted the EU's established regional development patterns, with implications for competitiveness, trade, and productivity growth. Consequently, we investigate the changes in the relationship of the UK with the rest of the European Productive Core and the broader implications for the EU regional dynamics post-Brexit.

At the opposite end of these spatial and economic frameworks lies Northern Italy, a region known for its dynamic and multi-sector economy. It has played an essential role in the economic development of the country, contributing substantially to national GDP (Gross Domestic Product) and job creation. Due to its proximity to major European decision-making centres, Northern Italy emerges as a significant case study for understanding economic development processes and broader regional dynamics. However, while many Northern European countries have pursued paths towards economic stability, the financial and economic crisis of 2008 triggered a significant decline in competitiveness and in overall wealth across the country, with major shockwaves in the North. These aspects have prompted legitimate

questions on the status of Northern Italy as part of the industrialised core of Europe, and whether it is still relevant to design it as the Southern edge of the geographical and economic region as identified by the empirical representations explored in this study.

Against this background, this paper examines the distinctive characteristics of the key models describing European development patterns, including urbanisation and infrastructure networks, employment, productivity, and competitiveness. The key findings, with respect to the UK, focus on the challenges faced by London in the aftermath of Brexit, alongside changes in the equilibrium of EU regional development. The UK, once a key node in the Blue Banana corridor, has experienced significant economic and political disengagement from the EU following its withdrawal in 2016, with cities responding unevenly to economic shocks (Martin, Gardiner, 2018). This departure has introduced complexities and potential threats to the cohesion of traditional spatial frameworks (Capoani *et al.*, 2024). Furthermore, with respect to the findings for Italy, the narrative of «Northern Saints, Southern Sinners» (Matthijs, McNamara, 2015) has resurfaced following the Eurozone crisis, highlighting Italy's challenges with competitiveness and declining wealth. While Southern Italy faces growth issues, Northern Italy, including the Lombardy region, has retained partial alignment with key Blue Banana characteristics. Notably, factors such as urbanisation, infrastructure networks, and strategic location in transportation corridors have contributed to its continued integration with the rest of the European industrialised core. However, recent difficulties in terms of unemployment, rising labour costs, inequality issues and productivity decline pose non-negligible risks. In light of these dynamics, Italy's role in these regional development frameworks deserves further scrutiny. Additionally, the rise of a polycentric model for capital city agglomerations, as in the case of the eastward economic shift of the EU, presents further questions not only in terms of positioning of the UK and Northern Italy, but also with respect to the validity of the frameworks of the Blue Banana and Pentagon themselves.

This study is divided into four sections, each addressing key aspects of this intricate economic landscape. Section 2 introduces the Blue Banana and Pentagon models, outlining their origins and main characteristics. Furthermore, it analyses regional and social trends shaping economic similarities in the core regions identified by these models. Section 3 examines the Blue Banana and the Pentagon's general applicability to the current European economic landscape, by analysing regional competitiveness across Europe. In particular, it focuses on two variables: the employment rate in high technology and knowledge-intensive sectors, and the NEET (Not in Employment, Education, or Training) rate. Additionally, it investigates the spatial clustering of these variables in order to assess their consistency with the Blue Banana and the Pentagon models. Section 4 explores the impact of Brexit on the Blue Banana and the Pentagon as Europe's core economic zones. It focuses

on non-tariff barriers, reduced economic openness, and implications for the labour market, infrastructures, and migration policies. Section 5 examines Italy's changing position within the Blue Banana and Pentagon in the aftermath of the 2008 financial crisis. Due to the fact that Southern Italy exhibits growth patterns similar to those of less affluent EU regions, concerns over the country's competitiveness and wealth remain. This section also evaluates Northern Italy's alignment with the characteristics of Europe's industrial core, and identifies persistent disparities despite partial compliance with certain criteria. Lastly, the results of the analysis suggest that socio-economic shifts, including the emergence of Eastern Europe, challenge the validity of these traditional models.

It is worth remarking that this analysis considers the Blue Banana and Pentagon within a specific temporal and methodological context, focusing on the late 2010s and based on selected socio-economic indicators. In light of these considerations, the paper critically reflects on the temporality and subjectivity of these frameworks, whose validity depends on context-specific variables. As such, the study investigates some of the several possible spatial representations of regional competitiveness within the EU.

2. From the Blue Banana to the Pentagon: spatial economic theories in Europe

The concept of the Blue Banana was first introduced in 1987 in a study by the French Interministerial Delegation of Land Planning and Regional Attractiveness (DATAR) and later presented by Roger Brunet and his team of geographers in 1989 (Brunet, Boyer, 1989). Brunet's research addressed the issue of Paris' over-centralization in the economic sphere (Faludi, 2015; Young, 1898; Loughlin, 2007), alongside concerns about the potential eastward shift of Europe's political and economic core. This work was developed during a period of intensified European integration, marked by the signing of the Schengen Agreement and the Single European Act – two major steps towards the establishment of a European Single Market¹. Within this context, «Blue Banana» was among the various names that were proposed for Brunet's concept of a European Backbone. According to Brunet, the choice of the blue colour originated from its use in an article by Alia (1989) in the French magazine *Nouvel Observateur*, and was later linked with both the European

¹ The fact that the main promoter of European integration was a French statesman probably had an impact on these concerns. As a matter of fact, from 1985 to 1994, the former French finance minister Jacques Delors was the President of the European Commission: the longest-serving executive with three mandates which gave new momentum to the process of European integration, initiating the process for the creation of the Euro currency and, above all, making a step forward the completion of the internal market.



Figure 1: The Blue Banana.
Source: Own elaboration.

Union flag and the attire typically worn by the so-called blue-collar social strata. The Blue Banana stretches from Northern Europe – Great Britain, the Netherlands, and Germany – to Southern Europe, covering Switzerland, Austria, and the economic nodes of Northern Italy, such as Milan, Turin, and Genoa (as shown in Figure 1). This area was considered as the heart of Europe due to its economic competitiveness, industrial strength, and significance in EU decision-making. The boundaries of the Blue Banana were drawn based on interpretive mapping techniques; the model was not the result of regression analysis, spatial economics, or clustering algorithms, which would later come to dominate regional science. This suggests that the Blue Banana was more of a practical device, meant to critique the uneven distribution of economic activity and to prompt spatial planning responses (Faludi, 2015). Only later would scholars attempt to align its spatial configuration with data on GDP, employment structure, and other variables. However, these findings were post hoc validations rather than the original basis of Brunet’s spatial definition. Brunet initially considered several key indicators, such as population density, urbanisation, and economic activities to define these boundaries (Klasen, Nestmann, 2006). Some scholars argue that the European Backbone was among the first continental regions to industrialise during the 19th century under Britain’s lead, as the potential origins of the Industrial Revolution (Hospers, 2003). The continuing relevance of this model has been reinforced by more recent theoretical developments. For instance, Redding and Rossi-Hansberg (2016) highlight how local economic shocks and endogenous firm-location decisions can trigger persistent spatial inequalities, leading to long-term divergences between regions (Lakócai, 2022). Applied to the Blue Banana, their framework implies that the cor-

ridor's early agglomeration advantages, inherent in historical shocks and infrastructural connections, become self-reinforcing through spatial spillovers² and reduced trade friction. This dynamic equilibrium explanation helps to assess the durability of high productivity and innovation levels, given those early advantages.

Despite Brunet's assertion that the Blue Banana should not be viewed as a product of globalisation policies, the region can be analysed as the outcome of specific social, political, and economic connections among its urban centres (Jacobs, 1969). These connections reveal unique patterns and features, highlighting the Blue Banana's role in the broader European context and the regional characteristics that shape the area's economic capacity. In this context, Brunet's spatial economic model was created to represent a «concentration of cities and people with similar historical roots» as a means of «documenting urban development as it was», rather than as a policy proposal for potential economic strategies for the region (Faludi, 2015). To better grasp this concept, it is useful to consider the Greater Rhineland region. This transfrontier area along the Western German border spans across a significant portion of the Blue Banana's territory. It owes its prosperity to multilingualism and multiculturalism – not to mention the great quantity of natural resources and the navigability of the Rhine, which form the basis for its economic strength (Loriaux, 2008). Similarly, Brunet emphasised that the region's many centres, just like building blocks, are crucial for its economic success. Understanding the regional and social characteristics of the Blue Banana also requires an understanding of its historical context, which was shaped by the uncertainty following the fall of the Soviet Union, the German reunification, and the Iron Curtain's collapse.

It remains unclear whether Brunet originally envisioned the polycentric configuration or if the current interpretation is the result of a contemporary re-evaluation. The original European Backbone *Dorsale Européenne* was not conceived as a «compact European metropolis» but rather as an «urban network reminiscent of what the European Bunch of Grapes stood for» (Faludi, 2015). Conversely, it can be argued that the Blue Banana area was not a relevant economic configuration during the European integration process, as nation-states were increasingly prominent in the early 20th century (Faludi, 2015). In this respect, the Organization for Economic Co-operation and Development (OECD) was the first to attempt a greater European economic coordination in line with the European Coal and Steel Community (ECSC), which was established in 1951. The beginning of this new era of economic connections led to increasingly blurred boundaries among Western European states, while emphasising the political and economic linkages throughout the centres of the Blue Banana.

² Spillover effects (or simply «spillovers») refers here to the influence that activities in one sector, region, or country exert on other sectors, regions, or countries.

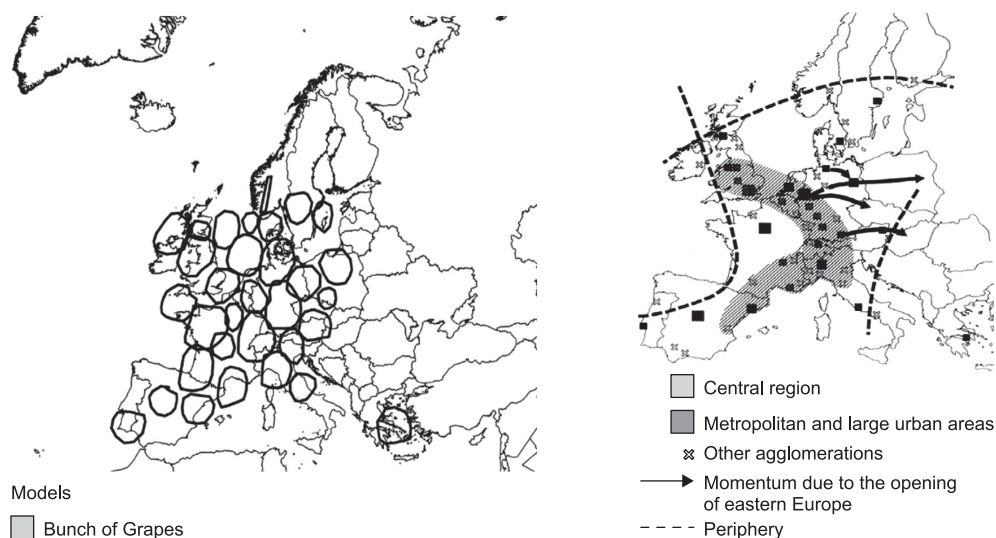


Figure 2: Maps of the European Grape (on the left) and the Blue Banana (on the right).
Source: Hospers (2003).

Faludi's mention of the «European Bunch of Grapes» provides a glimpse into how and why the Blue Banana concept has not gone uncontested. In the early 1990s, Kunzmann and Wegener (1991) suggested an opposing theory, introducing the concept of the «Bunch of Grapes». Rather than concentrating on a single, dominant core and drawing a distinction between one central and several peripheral territories – as the Blue Banana implies – these scholars identified a different pattern of European development based on multiple centres. Its metaphorical representation, which is known as the «European Grape» (Kocziszky *et al.*, 2015), suggests autonomy and collaboration among different locations, symbolised by the varying sizes of the «berries» (as illustrated in Figure 2).

The «European Grape» perspective facilitated the inclusion of newly integrated regions by simply expanding the original «grape». This approach allows for the seamless incorporation of Eastern European countries into the broader framework, thus providing a more adaptable representation of the European economic landscape. By contrast, the Blue Banana concept has faced criticism, particularly following the fall of the Iron Curtain in 1989. On one hand, newly established states on the verge of EU accession were excluded from the initial European Backbone planning. On the other hand, critics argued that the Blue Banana model fostered competition among EU Member States rather than encouraging cooperation (Kunzmann, Wegener, 1991; Dunford, 1994).

The «Bunch of Grapes» model is not the only instance of a new model emerging either in contestation or in a complementary fashion to the Blue Banana model. Some of the new models aim to anticipate future scenarios



Figure 3: The Pentagon.
Source: Szabó (2008).

of productivity and economic growth based on current trends. For instance, Hospers (2003) presents the concept of the «Yellow Banana», spanning from Paris to Warsaw, and the «Sunbelt», from Milan to Valencia. The author emphasises how these new potential models are not necessarily meant to replace the Blue Banana (although this will depend on future developments), but rather to serve as useful models for the interpretation of future developments in the configuration of the EU's Economic Core. In this sense, these models could be used both as an integration or as a useful tool of comparison for the Blue Banana model.

Another example of an empirical model used to analyse productivity, economic prosperity, and growth in the EU is the Pentagon model. Numerous studies have examined the social and economic attributes of European macro-regions, emphasizing their geographical placement and unique spatial traits. In some cases, the outcome has been a spatial representation where a geometric shape outlines the central region. The «Pentagon model», coined by Karlheinz Schön (2000) and developed within the EU's bureaucratic framework, represents a relevant example of such spatial analysis. This model identifies an expansive economic zone encompassing the metropolitan areas of London, Paris, Milan, Munich, and Hamburg. At the end of the 1990s, this area accounted for 50% of the total GDP of the EU, housed 40% of the EU's population, and covered 20% of the total EU territory. Its numeri-

cal designation, the «20-40-50 Pentagon», was coined by Pál Szabó (2008) based on these data. Since its inception, however, the statistics backing the Pentagon model have changed. For instance, in 2004, the Pentagon Economic Zone accounted for 18% of the EU15 land area, 41% of the population, 48% of GDP, and 75% of R&D expenditure.

This model gained prominence following its publication in the *European Spatial Development Perspective Journal* (ESDP) in 1999. The report showed that the majority of economic activity in the EU15 was concentrated within a densely populated, «pentagon-shaped» area formed by the aforementioned major cities (as shown in Figure 3). This region is characterised by high-quality employment opportunities and robust infrastructure, attracting both businesses and consumers. While this model is often associated with quantitative indicators, it is fundamentally underpinned by qualitative assessments of these factors. As a result, the EU Pentagon is widely portrayed as the core of Europe's economic development and global trade capacity, emerging as a significant centre for innovation, investment, and growing entrepreneurship.

Recent studies, for instance Puškarová and Vašková (2021), present compelling evidence that the economic influence of core regions – such as those within the Pentagon – continues to extend beyond their immediate geographic boundaries through spatial spillovers. These effects are not limited to capital flows or trade but include social and institutional effects driven by welfare policies and income redistribution. Their findings suggest that regions located closer to the economically stronger parts of Europe – often within or adjacent to the Pentagon area – are more likely to benefit from these mechanisms. For example, areas of Western Slovakia and the Czech Republic, due to their relative proximity to core EU countries, tend to experience stronger positive impacts from both national and EU-level redistributive measures. This underlines the importance of spatial location in shaping a region's ability to absorb and amplify the economic functions of the core. Such dynamics reinforce the analytical utility of the Pentagon model, not merely as a static representation of economic concentration, but as a dynamic framework that helps explain how growth and integration-related effects propagate – or fail to propagate – across regions. The model captures both the centripetal forces of agglomeration and the centrifugal logic of spillovers, offering a nuanced understanding of regional interdependence in Europe. Furthermore, the Pentagon serves as a key hub for financial support, allocating substantial resources for strengthening the Union as a whole. For instance, the European Investment Bank, headquartered in Luxembourg, provides funding for a wide range of projects across the EU. These include the European Regional Development Fund, which is considered a vital structural resource of the EU, besides the European Social Fund, aimed at fostering social inclusion, and finally the EU Cohesion Policy, which strengthens economic, social, and territorial cohesion.

Regional competitiveness depends on multiple factors, such as the level of education and social integration (Annoni, Dijkstra, 2019). In this regard, it is interesting to note how basic and higher education, along with long-life learning, are among the indicators used by the Regional Competitiveness Index (RCI)³. Poverty and social inclusion constitute one of the ten key factors identified by Kouskoura *et al.* (2024) to measure regional competitiveness. When considering the relationship between regional competitiveness and social inclusion and integration, one should not forget that this relationship often tends to be conflictual (Cellino, Soci, 2002). Policies geared towards an increase of regional economic growth and competitiveness have often been found to be at the expense of welfare policies, which are related to factors of social inclusion and integration (Cucca, Ranci, 2016). Therefore, this tension should be taken into consideration when trying to assess the impact of growth and competitiveness policies and especially the differentiated growth and development of regions.

Nevertheless, the rise of new growth centres beyond the Pentagon's boundaries suggests that economic prosperity is becoming more geographically dispersed across the EU, thereby diminishing the relevance of the model. Indeed, the Pentagon's contribution to the EU27 declined significantly in 2004 compared to 1995, while its share of the population remained stable (Szabó, 2008). An analysis presented in *The Regional Yearbook 2007*, focusing on Europe in the timeframe spanning between 1995 and 2004, uncovered a significant economic growth extending beyond the conventional core of the EU as denoted in the Pentagon. Emerging centres such as Dublin, Madrid, Helsinki, Stockholm, Warsaw, Prague, Bratislava, Budapest, Bucharest, and Sofia have become prominent. Throughout this period, capital city regions exhibited either a rise or a preservation of their share of national GDP with the exception of Berlin.

More recent contributions confirm that spatial location and interregional linkages continue to shape regional competitiveness in the EU. Carrascal-Incera *et al.* (2025) show that commercial networks and spatial spillovers play a crucial role in determining regional productivity, suggesting that proximity to economically integrated regions enhances a territory's capacity to benefit from growth dynamics. For instance, their simulations demonstrate how industrial regions in Germany and Belgium – despite their central location – can suffer productivity losses due to negative spillovers from less resilient neighbouring areas. This highlights the complex interplay between spatial embeddedness and economic shocks, showing that even highly connected core regions are not immune to contagion effects. These findings support

³ The Regional Competitiveness Index (RCI) is a composite index developed by the European Commission to monitor and compare development and competitiveness of EU regions (NUTS-2 level) over time, based on 68 indicators. It measures the ability of each region to offer an attractive environment for firms and residents to live and work.

the continued relevance of spatial frameworks such as the Pentagon, as they help capture the uneven geography of competitiveness and integration and provide analytical tools for understanding how growth and decline circulate through European space.

Interestingly, this pattern extends beyond the economic domain into the institutional realm. As Börzel and Risse (2012) argue, the uneven effectiveness of EU integration mechanisms is closely tied to the differentiated capacities of regions when it comes to the absorption and implementation of policies, for instance. Institutional readiness, which is shaped by historical, political, and infrastructural factors, conditions the success of policies at the local level (Turok, 2004). In this sense, models like the Pentagon and the Blue Banana are not only tools to visualize economic density, but also a means to map the structural conditions that determine how integration unfolds across regions.

In any event, the emergence of new centres of growth challenges oversimplified geometric models and advocates for a more nuanced understanding of urban and rural dynamics, thus favouring the application of a polycentric approach to Europe (Clark *et al.*, 2018). It is also true that most Metropolitan Growth Areas (MEGAs) still cluster within or around the original Pentagon. As a result, the EU Pentagon concept remains relevant, sparking concerns about imbalanced economic growth across Europe. In fact, the central productive areas are to be held responsible for engaging the surrounding peripheries in economic growth, ensuring that their potential contributes to a polycentric and interconnected production model (Rauhut, Humer, 2020). To address these challenges, the EU is undertaking significant efforts to reshape the current economic landscape through various programmes aimed at supporting the economic and social development of less-developed European regions.

Similarly to the Pentagon, the regions within the Blue Banana model are still regarded as important members of the European Economic Core, despite the new dynamic corridors of economic development. While some scholars continue to criticise the empirical validity of the concept (see Taylor, Hoyler, 2000), they acknowledge the role of the Central European Core of the Blue Banana, home to most cities recognised as advanced service centres. The persistence of this pattern over the past fifty years underscores the significant challenges faced by the European industry. According to Amin and Thrift (1995), Heidenreich (1998) and Puga (2002), this area has a substantially higher GDP per capita and lower unemployment rates than nearby non-core regions, thus providing empirical support for the continued relevance of the concept. Indeed, the Seventh Report of the European Commission (EC, 2017) and the EUROSTAT Regional Yearbook (2017) indicate that, despite efforts and some recent progress in overcoming territorial disparities, a mismatch persists within the EU, as shown by various Cohesion Reports (EC, 1996, 2001, 2004, 2007a, 2010, 2014, 2017). In summary, the areas within the Blue Banana region continue to share similar features, while nearby regions strug-

gle to achieve the same levels of economic and political stability, despite the rapid productivity growth of the Eastern neighbours.

These varying spatial models of Europe are supported by different sets of indicators and methodological approaches. For instance, the original Blue Banana is an empirical representation based on urbanisation patterns, industrial history, and qualitative mapping. By contrast, the Pentagon model emerged from EU-level spatial planning, relying heavily on quantitative indicators such as GDP, population density, R&D expenditure, and infrastructure capacity. More recent models, like the European Grape, or those using spatial econometric techniques, incorporate dynamic variables, such as spatial spillovers, network effects, and regional resilience. In a comparative analysis assessing the accuracy of the most popular spatial models for EU development, Dokov and Stamenkov (2015) comment that most models subsequent to the Blue Banana seem to depict a potential situation which would be the ideal outcome of European spatial planning policies. By contrast, the Pentagon, along with the Blue Banana itself, seems to be the most suitable to accurately represent the status quo of the EU's economic and productive configuration. It must be noted, however, that no single classification can claim universal validity. Each reflects a particular analytical lens and dataset, influenced by its historical and policy context. Consequently, our classification of European NUTS2⁴ regions, based on socioeconomic competitiveness during the late 2010s, must be seen as one contribution among many, grounded in a specific temporal and methodological framework.

3. EU core areas from a regional development perspective: an empirical overview

Drawing on the above, the Blue Banana and the Pentagon could still be considered as a useful spatial framework for analysing patterns of regional competitiveness in contemporary Europe. However, their empirical foundation has evolved to incorporate additional quantitative indicators, such as patenting activity and employment in high-tech sectors. In this section, we focus on two socio-economic variables that serve as proxies for the broader socio-economic features which determine regional competitiveness in Europe. The first variable is employment in high technology and knowledge-intensive sectors, expressed as a percentage of total employment. This reflects regions' capacity for innovation and economic modernisation, which are critical for maintaining competitive advantages. The second variable is the already

⁴ NUTS2 (Nomenclature of Territorial Units for Statistics, level 2) refers to a standardized EU classification of sub-national regions used for statistical and policy analysis. These regions typically represent provinces or large administrative divisions within Member States.

mentioned NEET rate, which refers to the share of young people (aged 15-29) who are not in education, employment, or training. This serves as an indicator of social integration, workforce potential, and labour market engagement which are all key determinants of long-term competitiveness (Eurofound, 2012). Both the variables are among the key indicators used by the European Commission to compute the RCI. Due to data availability (sourced from EUROSTAT) our examination is limited to the pre-Brexit and pre-pandemic situation for the years 2018-2020.

Empirical data indicate that, between 2007 and 2009, 40% of industries in the traditional manufacturing sectors moved eastward in Europe, while the most competitive, high-quality service-based sectors remained concentrated in the Western part of the continent. This trend has been partly offset by subsequent back-shoring, partially attributed to rising wages in some Eastern European regions (Kinkel, 2012). Nevertheless, the areas with the highest RCI scores continue to be concentrated in Western and Central Europe, whereas regions in the East, including EU Member States such as Bulgaria and Romania, still exhibit lower levels, especially in their non-capital areas (Lakócai, Capoani, 2023; Naudé *et al.*, 2019). These disparities highlight the persistent economic divide within the EU and suggest the need for alternative classifications of core and peripheral regions that account for diverse socio-economic dynamics.

The proportion of employment in high-tech and knowledge-intensive sectors relative to the total labour market in the area is a crucial factor to consider when analysing regional competitiveness. These key industries are typically at the forefront of innovation and economic growth, driving technological advancement, creating new products and services, and attracting both investments and talent (OECD, 1996). Within this context, the expansion of high-tech and smart industries is especially present within Blue Banana and Pentagon regions characterised by economic strength and innovative capacity. Our findings reveal that the areas with the highest employment rates in high technology and knowledge-intensive sectors are widely distributed across Europe (Figure 4).

Global Moran's I statistics, calculated using a distance-based spatial weight matrix⁵, confirm the absence of significant territorial concentration of employment in high-tech and knowledge intensive sectors (Figure 5)⁶. This dispersion suggests that innovation and technological development are not confined to specific locations but occur across various regions both within and beyond the European Core Economic Zone. It also highlights the importance

⁵ The threshold distance of contiguity is adjusted to correspond to the lowest bandwidth within which there is no isolate. In this particular instance, the threshold distance of contiguity is determined to be 373.8 kilometres between the geometric centroids of the regions in question.

⁶ The permutation test of the global Moran's I confirms the absence of spatial concentration (at $p = 0.05$).

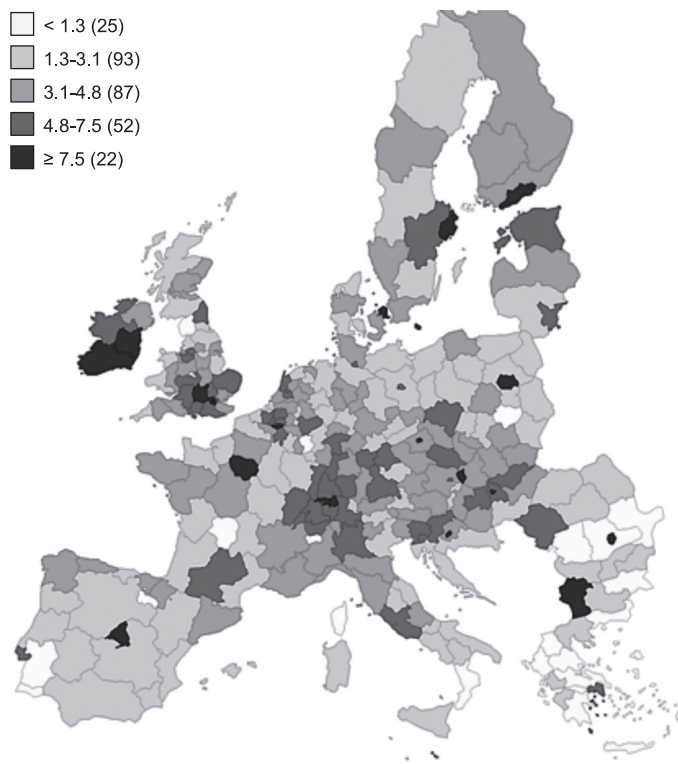


Figure 4: Employment rate in high technology and knowledge-intensive sectors in 2019.
Source: Own elaboration.

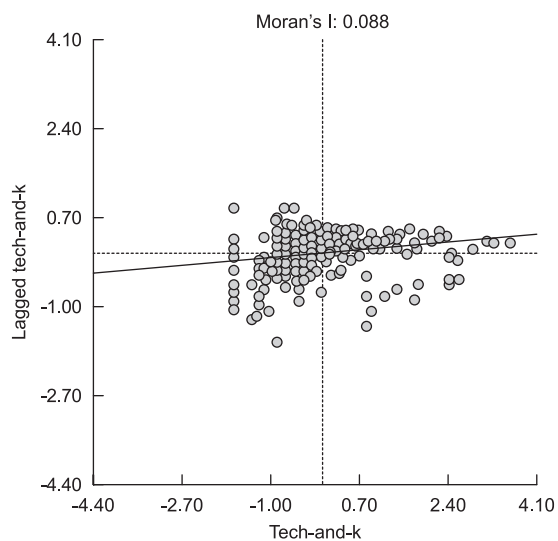


Figure 5: Global Moran's I statistics on the employment rate in high technology and knowledge-intensive sectors.
Source: Own elaboration.

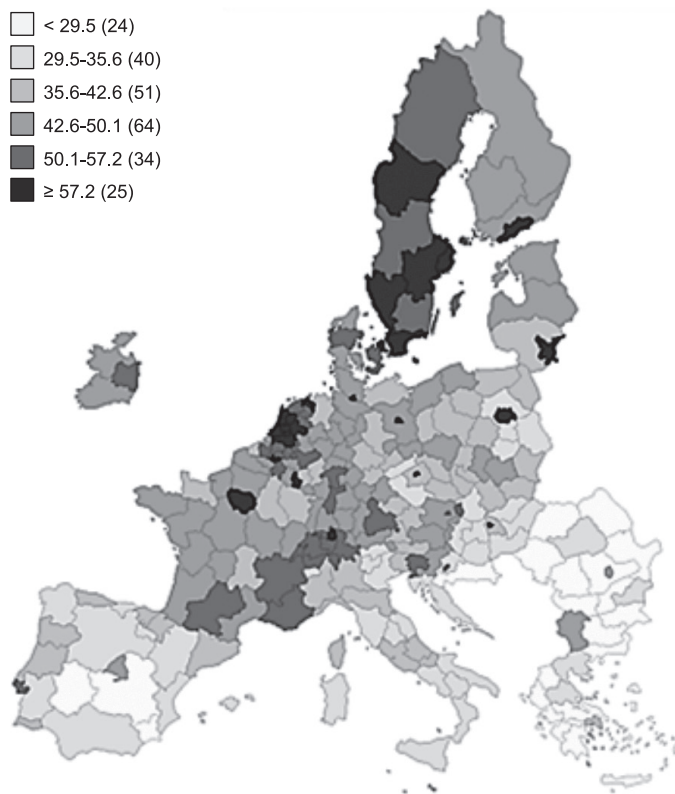


Figure 6: Highly-skilled employed people in 2022 (percentage of people employed aged 25-64).
Source: Own elaboration.

of promoting technological advancement outside traditional economic hubs, so to ensure that the benefits of these industries are more evenly distributed. Furthermore, the outcomes suggest that the capital regions in Europe have higher employment rates in the high-tech and knowledge-intensive sectors compared to their surrounding regions. This concentration underscores the role of cities as innovation hubs and centres of economic activity, thereby suggesting the existence of a polycentric model characterised by a dual dynamic between vibrant metropolitan areas and their comparatively less-developed peripheries (Nagy, Toth, 2016).

Regional data on highly-skilled employment⁷ (as measured by the percentage of people employed aged 25-64) indicates that most of the continental Blue Banana and Pentagon regions are above the EU average, with the notable exception of Italian regions (Figure 6). The most recent data available

⁷ Highly-skilled employment is defined by EUROSTAT as the percentage of employed people aged 25-64 who are employed in the following occupations: managers, professionals, technicians and associate professionals.

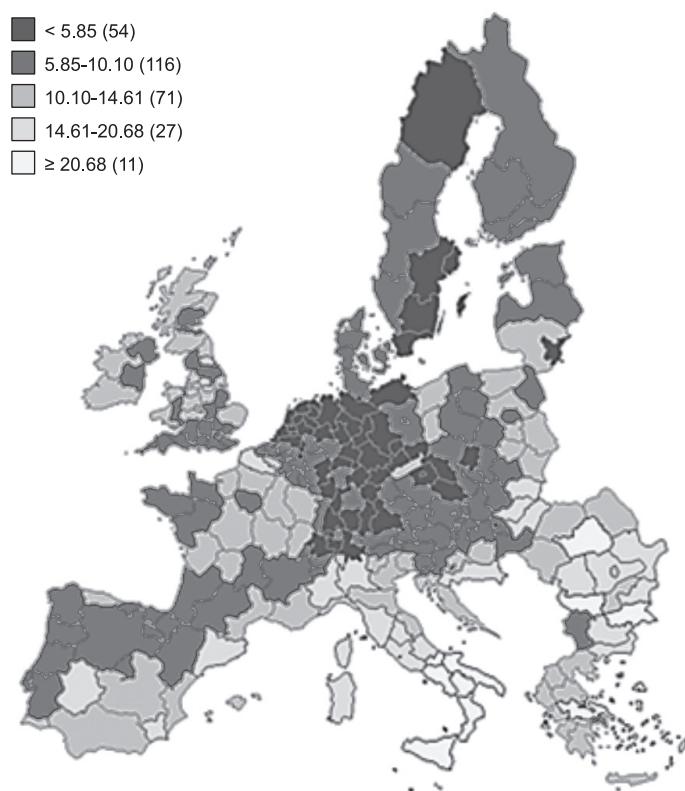


Figure 7: NEET rate in Europe in 2019 and 2020.
Source: Own elaboration.

for this variable, from 2022, pertain only to EU27⁸ NUTS2 regions, meaning that British regions are excluded from the analysis. Based on these results, it can be argued that the most productive and high value-added economic sectors remain predominantly concentrated within the Blue Banana and Pentagon areas, with Northern Italy being largely absent from this pattern. This data further calls into question the continued inclusion of Italy in the European Economic Core.

The next section considers the second variable. The NEET rate reveals significant territorial differences between concentration levels: they are low in most of the German, Swiss and some of the Central European regions, but high in the South-Eastern ones (Figure 7). These patterns are confirmed by the global and local Moran's I statistics presented in Figure 8: the graph on the left illustrates the overall spatial concentration of the NEET rate, while the map on the right provides a geographical visualisation of this result in

⁸ The EU Member States without Britain.

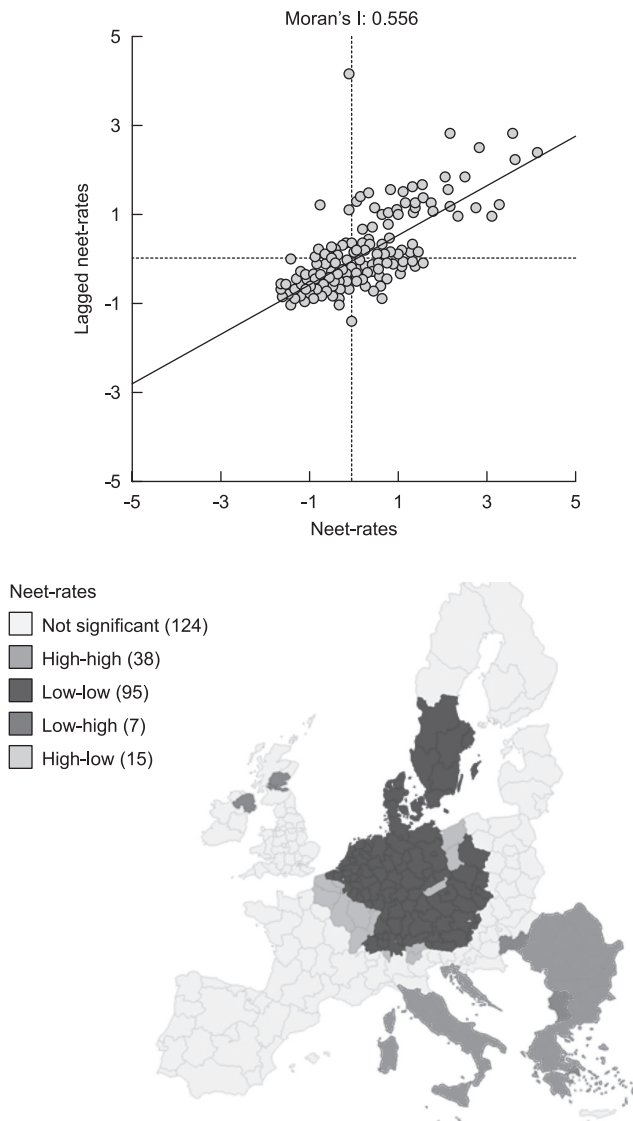


Figure 8: Global (above) and local (below) Moran's I statistics on the NEET rate in 2019-2020.
Source: Own elaboration.

terms of the local outliers based on the spatial weight matrix. Furthermore, NEET rates in large metropolitan regions may diverge significantly from their surrounding areas. London, and more generally, Southern England represent a case of lower NEET rates compared to nearby regions like Northern England and other areas of the UK. The same pattern occurs, even more markedly, for the metropolitan area in Paris, which has a lower NEET rate than all the surrounding regions of North-Eastern France. By focusing on the Blue Banana

and Pentagon areas, we can observe that the NEET rate is higher at both their northern and southern edges, than it is in their continental core regions (Benelux, Germany and Switzerland). This phenomenon further validates the question about the ongoing inclusion of the UK and Northern Italy in the Blue Banana region, their designation as edges of the Pentagon, and, more broadly, the contemporary applicability of these models.

By combining the two analysed variables, we can apply K-means clustering⁹ to classify the NUTS2 regions, and through the additional use of the Elbow method¹⁰, we take into account 5 clusters.

The map in Figure 9 suggests that the Blue Banana is not a homogeneous area, as the regions at the two edges belong to different clusters from most of the regions at its core. Similarly, the Pentagon model does not adequately illustrate spatial clustering because its edges belong to different clusters. Indeed, we observe an eastward shift in the contiguous core area, which now includes parts of Polish, Czech, Slovak, and Hungarian regions (Nagy, Toth, 2016). This aspect could be interpreted as a result of many manufacturing companies deciding to relocate most production phases to Eastern European countries (Zimny, Zawieja-Żurdoska, 2015). Yet, Benelux, West-German and Swiss regions of the original Blue Banana and Pentagon area remain part of this new core concentration. Capital regions such as London and Paris, which are considered key Western centres of the original Pentagon model, belong to the same cluster as most other capital regions in Europe. This implies that these agglomerations perform well with regard to the two combined socio-economic indicators. The rest of the French regions, as well as the area of Northern Italy, belong to lower-performing regional clusters, although they do not show the worst performance in absolute terms.

Overall, the results of the cluster analysis reveal a territorially contiguous core area partially overlapping with the original Blue Banana and Pentagon concepts, but with a significant shift eastward. Although the areas belonging to this territorial concentration are not necessarily the best performing – since a large number of the capital regions achieve better results – they do outperform most of the other regions outside this area. This suggests a twofold spatial socio-economic dynamic: a polycentric model of capital city agglomerations and a monocentric model of regional concentration shifting eastwards. While the British edge of the Blue Banana remains part of the former polycentric model, the Northern Italian edge appears displaced from the new continental core concentration, as shown in Figure 9.

⁹ The K-means is an unsupervised statistical algorithm used to divide a given dataset into groups (k clusters), effectively tackling the clustering problem through a simple process (Kodinariya, Makwana, 2013). K-means aims to partition data into K non-overlapping clusters by minimizing the within-cluster sum of squares, leading to groups of units that are internally as homogeneous as possible (Ikotun *et al.*, 2023).

¹⁰ The Elbow method is a popular technique used to select the adequate number of clusters in K-means. It involves plotting the number of clusters against the within-cluster sum of squares (WCSS) and identifying the «elbow point», where the rate of decrease in WCSS sharply slows, indicating diminishing returns for additional clusters (Ketchen, Shook, 1996).

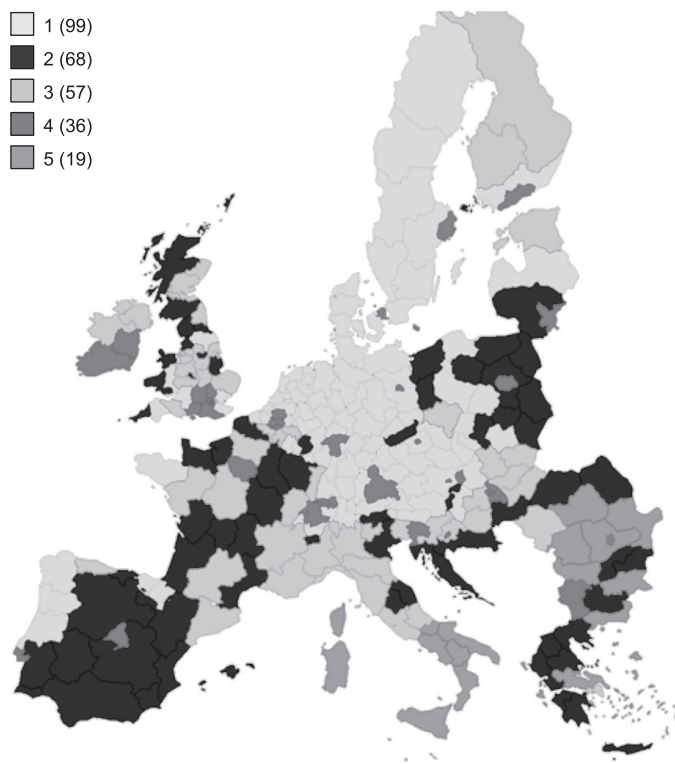


Figure 9: Clusters of the NUTS2 regions.
Source: Own elaboration.

The results demonstrate that some areas encompassed by the Blue Banana and the Pentagon continue to function as innovation hubs despite the economic development of Eastern Europe. Furthermore, this trend resembles centuries-old economic patterns existing in the continent since the late middle ages, with reference to the resurgence of long-distance trade and the establishment of quasi-autonomous urban centres (Mishkova, Trencsényi, 2018). Moreover, some regions within the Blue Banana and the Pentagon still exhibit promising potential in the European service economy due to their historically diverse economic structure and their well-developed industrial centres mainly focusing on the third sector.

4. Shifting dynamics of European regional development: Brexit's impact on the Blue Banana and the Pentagon

The aftermath of Brexit has sparked compelling questions about shifts within the EU's regional development landscape, thus affecting the representation of the Blue Banana and the Pentagon. This section seeks to go

beyond conventional spatial metaphors, particularly the Blue Banana, which has been gradually replaced by numerous alternative conceptualisations.

The EU's developmental trajectory faced difficulties in the aftermath of the 2004, 2007, and 2013 enlargements (Lightfoot, 2008), which – as already mentioned – exacerbated its predisposition towards a monocentric structure, particularly due to the lower development levels of the new Member States and their «unique situation of being recipients of aid from the EU while simultaneously preparing to become donors» (Carbone, 2004, p. 245). However, the UK's departure from the EU could be considered the key catalyst for a change in this trajectory. Britain represented one of the vertices of the Pentagon and played a key historic role in the Blue Banana not only in terms of geography, but also due to its high-level development performance. Brexit thus requires a close examination in terms of how regional core areas are positioning themselves in the broader European continent while adjusting to the new development landscape. This scenario offers a valuable and unique opportunity to analyse the changing regional pattern based on factual empirical data, which will help shed light on the immediate and long-term impacts of Brexit on EU regional dynamics.

One of the primary effects of Brexit has been its impact on the competitiveness of the Core Economic Zone, which has been notably constrained by trade limitations following the departure of what was the EU's largest trading partner (Dhingra *et al.*, 2016). Although no tariffs or quotas have been imposed, rules of origin checks and differing regulations on product standards and safety have created significant non-tariff barriers, especially for smaller firms. The added administrative burden has made it difficult for these firms to comply with the new regulatory framework, leading to a sharp decline in trade flows between the UK and EU, particularly in the initial stages following the implementation of the Trade and Cooperation Agreement (TCA) (Forster-van Aerssen, Spital, 2023; Bui *et al.*, 2024). Moreover, this transition has caused shifts in supply chain dynamics, prompting enterprises to reassess their operational strategies and contemplate potential relocations or adjustments in sourcing patterns. The response of firms may vary depending on market competitiveness, with those operating in highly competitive markets being inclined to absorb expenses or explore supply chain diversification. These changes have also significantly affected the market's level of economic competitiveness, along with other related factors, such as employment prospects and the economy's resilience (Bailey *et al.*, 2023). In the post-Brexit European competitive landscape, certain regions in France, Austria, Spain, Scandinavian countries and Northern Italy have witnessed an increase in competitive prospects. This trend was the consequence of reduced competition from the UK, where firms and industries largely relied on trade with the EU and have been consequently more vulnerable to the effects of Brexit (Thissen *et al.*, 2020).

In the service sector, a major consequence of the withdrawal is that UK firms have lost their automatic access to markets within the EU and now have to comply with differing regulations in each country within the bloc. While EU membership did not prevent UK companies from trading globally, the EU remained a crucial trade partner for London due to its proximity and market size. Although the economic impact of Brexit on firms is difficult to quantify, its effects are significant. Byrne and Rice (2018) estimate a 9.6% decline in trade flows, and Ottaviano *et al.* (2014) report a similar figure (10%), considering the potential loss from reduced non-tariff barriers for EU Member States. In particular, with respect to the effects of Brexit on specific region-sectors, tourism services are the most negatively impacted after manufacturing activities (Tsekeris, 2020).

The efficiency of the Core European Zone, as outlined by the Blue Banana, has also experienced repercussions. UK firms are now forced to sell their goods and services in a smaller market, resulting in significant losses in terms of economies of scale (Mathieu, 2020). Consequently, a decrease in economic openness might deter substantial investments, potentially limiting technical innovation and the access to imported technologies. Considering the substantial costs associated with technical innovation, significant sales are necessary to amortise these expenses. The negotiations surrounding the Brexit deal led to increased uncertainty, resulting in a gradual decline in investments by approximately 11% in the three years following the June 2016 vote (Bloom *et al.*, 2019).

According to classical international trade theory, a smaller market typically reduces competitive pressure in order to allow less efficient firms to survive, but this leads to a decline in productivity growth (Krugman *et al.*, 2009). This decline, measured in terms of added value, has averaged around 1% per year since 2016, while employment initially remained stable due to labour hoarding and government support during the COVID-19 pandemic, such as the Coronavirus Job Retention Scheme (Forster-van Aerssen & Spital, 2023). Nevertheless, productivity has fallen (Bloom *et al.*, 2019) with highly productive firms in sectors like textiles, chemicals, and electronics experiencing declines of up to 2.27% (Latorre *et al.*, 2020). By contrast, less productive firms have benefited from protectionist policies, reducing competition and imports (Latorre *et al.*, 2020). On the one hand, this has a lasting impact on GDP and its growth rate. On the other hand, productivity growth is already slowing down in the most advanced countries (Bergeaud *et al.*, 2016; Saltari, Travaglini, 2008). Therefore, the impact of economic openness on productivity may fall short of expectations (Mathieu, 2020). In this respect, the UK performance in terms of productivity is lower, especially in comparison to other OECD countries (Kierzenkowski *et al.*, 2016). It ranks below the average of the euro area, and is much lower than France and Germany, while being just slightly ahead of Italy and Spain (Van Ark, O'Mahony, 2023).

The longer-term consequences of Brexit for the labour market are increasingly evident. The UK has experienced a notable decline in employment compared to pre-Brexit projections, driven by stricter migration policies and economic adjustments (Bui *et al.*, 2024). Labour shortages have been exacerbated by the reduced influx of EU workers, particularly in low-skilled sectors like hospitality and transport, which had traditionally relied on EU migrant labour (Forster-van Aerssen, Spital, 2023; Portes, Forte, 2017). By contrast, according to recent OECD economic assessments (OECD, 2014, 2019), the EU will experience an increase in employment and wages in the coming years. Furthermore, from 2000 to 2009, UK regions had a significantly lower NEET rate¹¹. However, this advantage no longer persisted between 2010 and 2019. Additionally, early leavers from education also showed a similar trend, with UK regions displaying a reduced prevalence in the earlier time frame but no longer maintaining a significant advantage in the subsequent period¹².

Connectivity to other parts of the region is another aspect that determines whether a region can be considered part of the Blue Banana and the Pentagon. With regard to the infrastructure, the TCA established the legal frameworks for both EU and UK to maintain air, road, rail, and maritime connectivity. Despite this basis, the UK has been faced with several infrastructure limitations post-Brexit. As a great example, the UK is no longer part of the 2007 Open Skies agreement between the EU and the US, which had allowed airlines to operate freely between the signatories without the need for additional regulatory approval (Airport Council International, 2015). When it comes to creating a market for infrastructure, standardisation should not be underestimated, because it can reduce transaction costs and improve network externalities (Besen, Farrell, 1994). Despite this domain often being managed at the level of the United Nations (UN), the EU still plays a significant practical role. The new Intercity Express Programme train, for instance, has been specifically designed to run on British railways (Rosewell, 2017). In this respect, most infrastructures in the UK are owned and operated by private entities, which may prefer to avoid EU standardisation practices to maximise profit. However, this would undoubtedly reduce connectivity with the rest of the Core Economic Zone and across Europe.

The circulation of people is a critical issue, particularly considering that migration significantly influenced voters' decision to leave the EU. The discourse on migration has become central, reflecting broader concerns about cultural identity, economic stability, and social cohesion (Burrell, Hopkins, 2019). The shift represented by Brexit poses a significant threat not only to the competitiveness of the UK, but also to the frameworks of the Blue Banana

¹¹ On the NEET, please see Section 3.

¹² Defined as persons aged 18 to 24 who meet the following two conditions: (a) the highest level of education or training they have completed is ISCED 2011 level 0, 1 or 2 (ISCED 1997: 0, 1, 2 or 3C short), corresponding to a lower secondary education, and (b) they have not received any education or training (i.e. neither formal nor non-formal) in the four weeks preceding the survey.

and the Pentagon themselves. More critically, it challenges the connectivity and shared sense of belonging to a European productive area. In addition to the repercussions for UK businesses exiting the Blue Banana and the Pentagon, European residents will no longer see the UK as a Member State where they could potentially migrate to and might even start to perceive it as a foreign country (Galpin, 2017). Brexit's repercussions thus extend far beyond immediate economic effects, as they also affect interconnectedness and collective identity within the European economic framework.

In sum, Brexit has not only politically detached the UK from the EU, but it has also drastically reduced its integration with Europe's economic core, with significant implications for regional development, trade, and economic and social dynamics. Overall, these effects translated into a 6.4% reduction in worldwide UK exports and a 3.1% diminution in imports, ultimately caused by a drop in economic relations with the old continent (Freeman *et al.*, 2024). As a result, Britain's future trajectory will likely diverge significantly from the shared economic pathways of the Pentagon and the Blue Banana regions, due to factors that include reduced access to the EU single market, the European identity crisis, evolving trade barriers, and reconfigured supply chains, all of which could lead to diminished economic integration, lower foreign direct investment, and long-term competitive disadvantages compared to its European counterparts. The post-Brexit challenges and transformations call for adaptive policies and continued analysis to navigate the evolving regional development dynamics within and outside the Union.

5. Examining Northern Italy's role in the Blue Banana and the Pentagon

Since the 2008 European financial and economic crisis, the regions covered by the Blue Banana and the Pentagon have encountered significant challenges. Over the years, the change of the region's spatial configuration into a polycentric dimension has come at the expense of the Mediterranean regions, although this pattern is affecting the entirety of the EU, as the competitiveness measurement index demonstrates (Schwab, 2012). In this respect, Southern Italy stands out as it has experienced growth levels comparable to less wealthy and more technologically underdeveloped areas of the Union, such as parts of the Iberian Peninsula, Greece, and the Balkans. The «Northern Saints, Southern Sinners» narrative (Matthijs, McNamara, 2015) resurfaced during the sovereign and debt crises and continues to be relevant, despite changing dynamics. Italy, and in particular its northern regions have also experienced a significant decline in competitiveness and overall wealth. While many of the Northern European countries managed to return to relative stability, Italy has faced persistent economic challenges, prompting questions about its continued relevance in the context of the

geographical concepts of the Blue Banana and the Pentagon. The main question revolves around the unique position of Northern Italy, with particular attention to the city of Milan, as a key vertex of the identified models. The socio-economic situation of Northern Italy deserves an in-depth study not only because of its historical position in the original framework of the Blue Banana, but also as a means to analytically and critically assess whether the region can still be regarded as an economic and industrial pole of European productivity, regardless of the empirical spatial boundaries adopted. This section thus examines Northern Italy through the lens of six criteria identified in the relevant literature as key features of the two spatial frameworks. These are, respectively, urbanisation, infrastructure, employment, productivity, corruption, and competitiveness.

Firstly, in terms of urbanisation, the territories included in the empirical models are densely inhabited and urbanised (Figure 10) with 40% of the EU's population residing between London, Amsterdam, Brussels, Frankfurt, Zurich, and Milan. Over time, this vast area came to be known as the *European Megalopolis* (Kunzmann, 2007; Faludi, 2015). In this respect, Italy still meets the population standards of the models, especially in the populous provinces of Milan, Varese and Monza, albeit less densely populated than other European centres. Milan, specifically, has a population density of approximately 7,430 inhabitants per square kilometer (Istat, 2023), which is among the highest in Europe, exceeding even Greater London's 5,854 inhabitants per square kilometer (Office for National Statistics, 2023).

Secondly, infrastructure is a crucial characteristic of Northern Italy (Hospers, 2003) with particular reference to the development of transport and telecommunication networks (Bertamino *et al.*, 2016). In order to reduce economic inequalities and to promote cohesive development, the EU focuses on numerous growth schemes centred on infrastructure-related projects (Cermakova *et al.*, 2015). In terms of passenger transportation and interconnection of urban nodes, the Lombardy region is a fully integrated component of the Blue Banana and Pentagon models; it is also home to the intermodal centres of Busto Arsizio-Gallarate and Milan-Melzo, regarded as important logistics hubs (Pastori *et al.*, 2014). Furthermore, Northern Italy represents a favourable location to connect shipment flows from Austria, Germany, and France. A key example that well represents the solid infrastructure connectivity and commercial ties between these areas is the Rhine-Alpine corridor, which ends at the maritime port of Genoa and cuts through the upper part of the Italian peninsula (Capoani *et al.*, 2022). This feature, along with its decades-long industrial progress, accounts for the growth of the region's logistics sector (Lupi *et al.*, 2018). To conclude, we can state that as far as the overall infrastructure is concerned, Northern Italy remains an integral part of the productive region of the Blue Banana and Pentagon (Schade *et al.*, 2016).

Thirdly, unemployment emerges as a crucial factor to consider in this analysis. According to Faini (2003), Italy has experienced a consistent rise

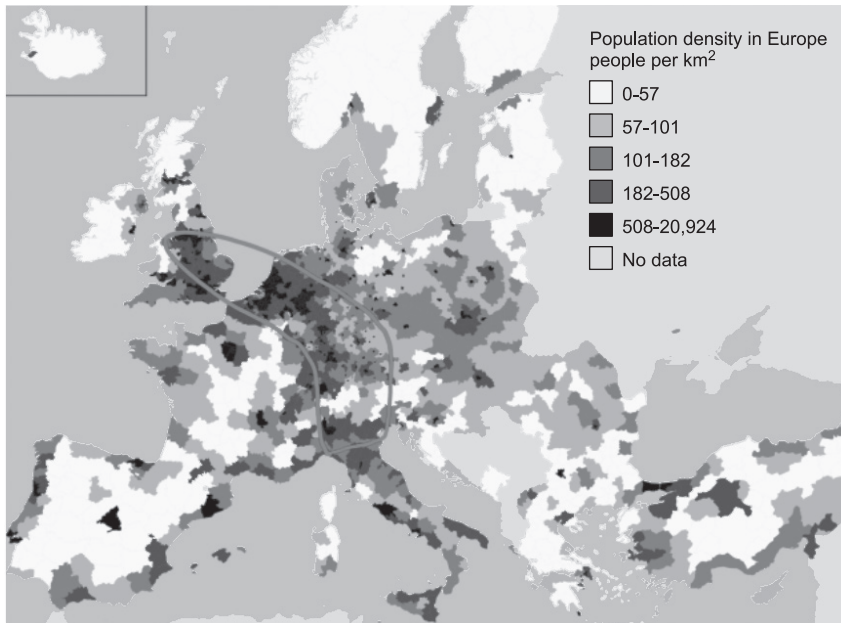


Figure 10: European population density map.
Source: Juric (2021).

in unemployment rates from 1996 onwards, with an average annual increase of 1.1%. The introduction of the Euro seemed to stabilise not only Italy's unemployment, but also regional rates across the entire euro area (Andersson *et al.*, 2015). Nevertheless, the 2008 global financial crisis led to a widening inequality in joblessness (Puga, 2002; Beyer, Stemmer, 2016) and increased variation in unemployment rates. To reduce the unemployment gap, Italy introduced the 2014-2015 Jobs Act, to align the labour market regulations with those of the EU and consequently with the rest of the Blue Banana (Pinelli *et al.*, 2017). Nonetheless, disparities in regional unemployment rates led to unequal effects across the country, with the regions registering better outcomes, namely the Northern ones (Marino, Nunziata, 2017). Unemployment rebounded in the following years, reaching pre-crisis levels in 2017 and 2018 (Bull, 2018; Moschella, 2017; EC, 2017) while rates in the central and Southern regions of the country remained significantly higher than in the North (Marino, Nunziata, 2017). By 2019, Northern Italy's unemployment rates were comparable to those of Western European countries outside the Core Economic Zone, despite being still higher than the unemployment rates within the Blue Banana region. To put it into perspective, Lombardy's unemployment rate in 2021 stood at 6% (EURES, 2023), significantly higher than Germany's 3.6% (World Bank, 2024), while lower than the Italian average of 9.7% (EURES, 2023). Youth unemployment and the NEET population further exacerbate the joblessness rate: In 2021, Lombardy's

youth unemployment rate reached 21.2% (EURES, 2023), much higher than Germany's 6.7% (World Bank, 2024). The growing proportion of NEETs, as it has been shown above, is a serious obstacle to Northern Italy's development of a highly skilled workforce, which is in turn critical to sustaining competitiveness in high-value sectors and aligning with the Blue Banana's economic performance benchmarks.

In terms of labour and productivity, Italy's unit labour costs are significantly higher compared to other euro area Member States, and they have been on the rise (De Grauwe, 2007). The general low productivity is the underlying issue, rather than the differences in wages and total income with respect to other countries: when compared to EU Member States with similar GDPs, such as France and Germany, Italy proves to be an exception (Calcagnini, Travagnini, 2014; Lotti, Santarelli, 2001; Sterlacchini, Venturini, 2014) as it is the only country where labour productivity growth rates have consistently slowed down over the past three decades. Between 2000 and 2022, the real yearly output in Italy grew on average by only 0.3%, significantly lagging behind the euro area, where actual output grew between 1.2% and 1.3% annually (Greco, 2023). Cumulatively, real output in Italy increased by just 7% over these two decades, which is almost four times lower than in the benchmark countries. Besides the COVID-19 crisis and the subsequent recovery period, Italy's economy lagged behind even more prominently (*ibidem*). Productivity can be assessed through a quantitative analysis of the firms' birth rate, measured by dividing enterprise births by total active enterprises. The results prove that Northern Italy's enterprise birth rate falls below the Blue Banana and Pentagon average: This aspect seemingly supports the concept of «lock-in context», which suggests that establishing a new business in such an area might present considerable challenges (Calcagnini, Travagnini, 2014; De Noni *et al.*, 2017).

Another significant factor to consider when analysing Northern Italy's position within the Blue Banana is the level of perceived corruption, as measured by the European Quality of Government Index¹³. The EQI pillar highlights stark disparities between Northern Italy and other regions within the Blue Banana, implying that Northern Italians might not have trust in public administration bodies, if compared to other European citizens. For instance, the scores of Lombardy (-1.04), Emilia-Romagna (-0.68), and Liguria (-0.63) are notably lower than the scores of key Blue Banana regions, such as Zuid-Holland (+1.20), Luxembourg (+1.28), and Darmstadt (+1.02). This becomes even more evident when using the same index to compare Northern

¹³ The European Quality of Government Index (EQI) is a composite measure used to capture average citizen perceptions and experiences with corruption, quality and impartiality of three essential public services – health, education and policing – in their region of residence (European Commission Directorate, 2021). It is a standardized measure, ranging between -3 and +3, where a positive value indicates perceived quality of government which is above the EU average, and a negative value indicates the opposite.

EU average is 0; negative value are below the EU average; positive values are above the EU average

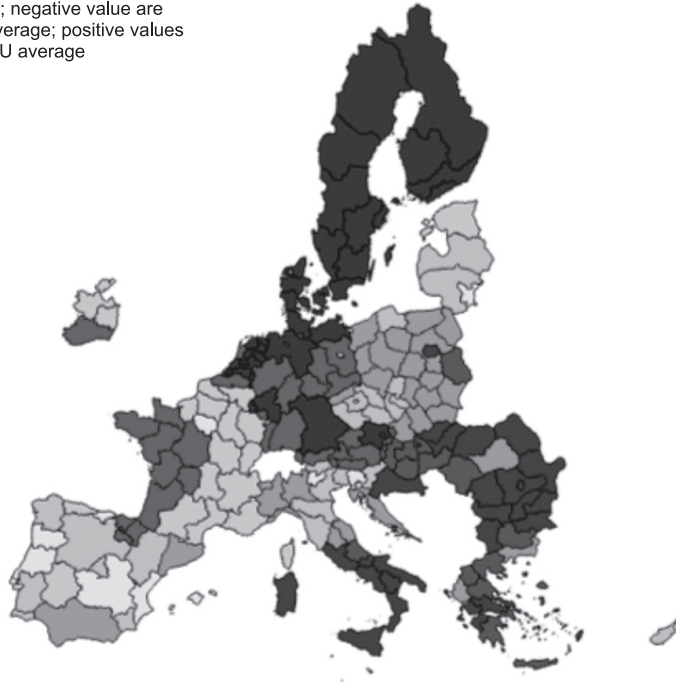
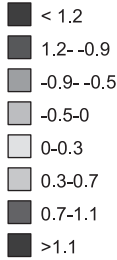


Figure 11: European map showing EQI values in 2021.
Source: Charron *et al.* (2024).

Italy with southern Italian regions like Sicily (-1.46), Campania (-1.98), and Calabria (-1.70), where governance issues appear even more severe (Charron *et al.*, 2024). Poor governance and corruption directly affect the efficiency of public services and hinder innovation and sustainable growth, further undermining the region's status within Europe's Economic Core.

Finally, it is worthwhile to briefly mention Italy's economic competitiveness. To analyse this aspect, we can rely on the RCI (Regional Competitiveness Index), which shows that Italy ranks 18th behind both Cyprus and Portugal. When considering Italian regions, Lombardy holds the highest rank at 128th place, with Sicily positioned at the bottom, in 235th place. The data reveal a downward trend in Italy's ranking over the years, dropping from 16th place in 2010 to 18th place in 2013. The country's fall in the ranking is reflected at the regional level: according to the latest dataset, Lombardy performs worse than other neighbours within the Blue Banana area. This suggests that the region holds a borderline position in terms of economic competitiveness and that major adjustments are necessary to maintain its relevance in the European marketplace.

The following comparative table illustrates and summarizes the 6 criteria considered above, highlighting the differences and similarities between

Table 1: Comparative overview of six structural criteria: Blue Banana vs. Northern Italy (1990-2020)

Six criteria	Blue Banana	Northern Italy
Urbanisation	Densely urbanised (40% of the EU population)	Urbanised, but less dense (key centres: Milano, Varese, Monza-Brianza)
Infrastructure	Advanced and interconnected logistics networks	Key logistics hubs and Rhine-Alpine corridor
Unemployment	Low (in 2021, Germany: 3.6%. youth 6.7%)	High (in 2021, Lombardy: 6%, youth: 21.2%. Italian average 9.7%)
Productivity	High productivity and high real GDP growth (1.2%-1.3% annual GDP growth 2000-2022)	Slow productivity growth and low real GDP growth (0.3% annual GDP growth 2000-2022)
Corruption	Low perceived corruption	High perceived corruption (internal Italian disparities)
Competitiveness	Highly competitive regions (RCI vertices)	Low competitiveness (Lombardy ranks 128th in RCI)

Source: Author’s own elaboration based on data from the Regional Competitiveness Index (RCI).

the rest of the Blue Banana and Northern Italy over the past three decades (1990-2020).

The results above confirm that Northern Italy’s inclusion in the European Core Economic Zone is still open to question. However, the region’s footing is supported by key indicators such as urbanisation, infrastructure development, employment, and productivity. The criterion of urbanisation is fulfilled by Northern Italian regions, with the cities of Milan, Varese, and Monza Brianza meeting the aforementioned population standards, for instance. Intermodal hubs and industrial progress attest to Lombardy’s infrastructural development, which is crucial for a balanced growth. The significant factor of unemployment reflects regional disparities, but Northern Italy still benefits from positive outcomes in terms of employment. Nonetheless, rising unit labour cost and decreasing productivity raise vital concerns. Finally, Northern Italy’s economic competitiveness, measured by RCI indicators, has declined, hence the uncertain position of Lombardy as a component of the Blue Banana and the Pentagon, and, more generally, as a key part of the economic heart of Europe.

6. Conclusions

This paper aims to reassess the relevance of the Blue Banana and Pentagon models against the evolving regional development dynamics in Europe on the basis of empirical economic, political and social factors. It is important to remark that these spatial frameworks lack a universally agreed or formally

established spatial definition. Drawing on the literature, the study of such models provides an intuitive foundation to discuss and interpret patterns of European regional development in the past, in the present, and in the future. A continuous assessment of the models' relevance and applicability is of paramount interest not only from an empirical standpoint but also in terms of their continued interpretative utility (Boschma, 2004). That said, it must be acknowledged that no spatial classification is definitive or free from limitations. The validity of these frameworks depends on the choice of variables and time periods under investigation. Accordingly, the classification presented in this paper is not absolute but reflects a specific interpretation exclusively for the late 2010s, assessed at the competitiveness level of the NUTS2 regions in terms of formal socio-economic indicators.

In Section 3, we evaluated the Blue Banana and the Pentagon's performance as applied in contemporary Europe in terms of economic growth and competitiveness. A focus was placed on the analysis and spatial clustering of two socio-economic variables that shape regional competitiveness in Europe, namely the employment rate in high technology, knowledge-intensive sectors relative to total employment, and the NEET rate. The results suggest the existence of a dual spatial and socio-economic transformation process consisting of a polycentric model of capital city agglomerations and a monocentric model of eastward-shifted regional concentration. Although suitable to parts of the Blue Banana and the Pentagon, this dual model poses challenges as to its full applicability.

In Sections 4 and 5, we examined the ramifications of Brexit and Northern Italy's overall decline in economic performance, and we scrutinized the impact of these phenomena on the macro regions considered. The decision to focus on the UK and Northern Italy was guided by the relevance of the roles these two regions have played in the evolving dynamics of the European economic core. Historically, they have been emblematic of European economic competitiveness, while also representing the northern and southern poles of the Blue Banana. Today, the UK offers a unique example of political, institutional and economic withdrawal from the EU. Contrastingly, Northern Italy shows signs of a gradual contemporary economic resumption following a significant crisis. While also other EU areas exhibit changing regional dynamics – which are currently ongoing, thus requiring an in-depth study in the near future – the comparative approach adopted in this paper enables a more targeted and meaningful analysis reassessment of the current relevance of both the Blue Banana and Pentagon spatial frameworks.

In the post-Brexit scenario, the reduction in the UK's productivity and competitiveness could potentially pose challenges to the country's positioning within the Blue Banana and the Pentagon. Moreover, the infrastructure and migration policies adopted by the British government could severely undermine its ties with the European Economic Core over the long run, thus compromising the validity and coherence of the empirical representa-

tions. In any event, these outcomes need further investigation to obtain a better overview of the situation in the long term. Regarding Northern Italy, this study has shown that the region is adequately positioned within the mentioned frameworks both in terms of urbanisation and infrastructure, whilst it lags behind with respect to unemployment rate, productivity, and competitiveness. Also in this case, further scrutiny of these factors could lead to a better assessment of the region's positioning within the areas mentioned.

Drawing on the above, increased efforts by the EU Institutions – most importantly with reference to the budget dedicated to the cohesion policy – could certainly make a difference in terms of convergence of some countries, while avoiding the overcentralisation of regional development. Since the EU cohesion policy is a shared competence – Article 4(2) TFEU – a greater role of Member States in co-funding and implementing the proposed programs at supranational level could be a game changer for the absorption of these policies at local level, thus avoiding disparities within and between countries. With regard to the case studies in this paper, the efficiency of EU-UK relations in terms of European regional growth could be only reached and be mutually beneficial once both parties, Brussels and London, fully comply with the TCA. Moreover, relaxing the restrictions imposed by post-Brexit immigration policies could facilitate the movement of labour across the Channel. For the Italian regions, the management of European funds should be aimed at improving the infrastructure network, transport: this requires an excellent management of such resources with innovative approaches, starting at the local level, so as to upgrade both the internal connectivity and the integration with the rest of the continent.

These findings provide significant insights on the status of the frameworks adopted to study regional development dynamics in Europe, although the scope of the paper does not cover other critical dimensions, such as economic performance, income distribution, or wellbeing. Future research could extend the analysis to include these indicators in a further exploration of whether the eastward shift manifests consistently across different other socio-economic dimensions. Furthermore, it would be of particular interest to examine how regional clustering, and socio-economic conditions have evolved across different time lags, allowing for the detection of trends and the identification of potential timing correlations with latent factors or major historical events. This temporal analysis would help test the robustness of the Blue Banana and Pentagon frameworks over time and could suggest the formulation of policies to address the challenges faced by Western European regions, including our case studies on Northern Italy and UK. Finally, based on the findings presented here, subsequent studies may investigate wage gaps, poverty levels, and other factors hindering full cohesion within the Blue Banana and Pentagon, while considering the broader implications of the region's shift towards the East for a deeper understanding of its future development.

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