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Shedding Light on Global Competitiveness by Analyzing Regional Competitiveness within the European Monetary Union

Arrojando luz sobre la competitividad global mediante el análisis de la competitividad regional dentro de la Unión Monetaria Europea

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Abstract

A review of the current literature reveals a lack of studies that directly address the relationship between regional competitiveness and monetary union. We make a contribution to the debate on the measurement of competitiveness in a monetary union by incorporating the territorial dimension. We develop a novel measure of regional real exchange rates as a proxy of regional competitiveness, analysing 127 Eurozone regions over the period 2003–2021. The findings of our study offer two key insights. First, we observe a geographical distribution of the real exchange rate, indicating that regional competitiveness is not only unevenly distributed across regions but also evolves over time. Secondly, we identify neighbouring effects from spatial dependence, which demonstrates that the competitiveness of a given region is influenced by that of neighbouring regions.

Keywords: Regional Competitiveness, Real Exchange Rate, Economic Monetary Union, Neighbourhood Effect.

Resumen

No existe una literatura extensa que relacione la competitividad regional en una unión monetaria. Se contribuye al debate sobre la medición de la competitividad en una unión monetaria incorporando la dimensión territorial. Se desarrolla una medida novedosa de los tipos de cambio reales regionales como aproximación de la competitividad regional analizando 127 regiones europeas durante el periodo 2003-2021. Los resultados ponen de relieve dos aspectos clave: se observa una distribución geográfica del tipo de cambio real, lo que indicaría que la competitividad regional no sólo está desigualmente distribuida entre las regiones, sino que también evoluciona con el tiempo. Además, se identifica la existencia de efecto vecindad a través de dependencia espacial, en la que la competitividad de una región concreta se ve influenciada por la de las regiones vecinas.

Palabras clave: Competitividad Regional, Tipo de Cambio Real, Unión Económica y Monetaria, Efecto vecindad.

JEL Classification/ Clasificación JEL: E4, F15, C23.

1. Introduction

The advent of globalization has underscored the paramount importance of competitiveness, a notion that has been further accentuated by the increased exposure to foreign markets and competitors (e.g., Bresser-Pereira, 2010). This heightened competitiveness poses significant challenges, particularly in the context of competition with low- and middle-income countries that boast lower labour costs (Rodrik, 2003). Among the key benefits of enhanced industrial competitiveness are improvements in productivity, increased exports of manufactured goods, and, most importantly, higher economic growth (Zhang, 2010). However, within monetary unions, where countries are unable to devalue their own currencies, competitiveness must be achieved through adjustments in wages and prices (Santos-Silva and Tenreyro, 2010). Furthermore, the discussion must encompass regional considerations, as industry tends to concentrate in specific areas within countries (Krugman, 1991; Lu and Tao, 2009), resulting in significant spatial disparities. Consequently, previous studies have applied the theory of competitive advantage to regional competitiveness (Zeibote et al., 2019). This reinterpretation may facilitate a more nuanced comprehension of the shift from global to regional competitiveness, offering profound insights into the scope and ramifications of regional competitiveness.

The discussion surrounding regional competitiveness remains unresolved, and the impact of the European Monetary Union (EMU) in this area is a focal point of the debate. On the one hand, the EMU has contributed to increased trade flows by reducing transaction costs (e.g., Alesina et al., 2002; Camarero et al., 2013; De Grauwe and Skudelny, 2000) and, hence, is expected to foster convergence in competitiveness. In this body of literature, the regional dimension is paramount, as trade impacts are found to be contingent on the introduction of within-country trade (Esteve-Pérez et al., 2020), and trade has the potential to attenuate disparities in competitiveness among regions. On the other hand, structural reforms resulting from the adoption of the euro have had an impact on the product market (Alesina et al., 2008) and could favour divergence in competitiveness. Furthermore, regions could play a pivotal role, as Krugman's (1991) dual scheme suggests that discrepancies between core and peripheral regions could intensify.

A review of the literature on regional competitiveness reveals a conspicuous absence of discourse on the implications of the EMU for regional competitiveness. Cerqua et al. (2023) directed their attention to the financial

benefits accruing from the adoption of a common currency. Barbosa and Alves (2011) examined the impact of the theory of optimum currency areas on regional economies, while Aman et al. (2022) investigated the role of institutional agreements. However, the spatial dimension, in which the impact on a specific region is dependent upon the characteristics or conditions of its neighboring regions (Anselin, 1988; Kelejian and Piras, 2017), has not been sufficiently addressed in the existing discourse. The only exception is Stoykova (2021), who studied the role of currency unions, compared with fixed exchange rates, in increasing bilateral trade among regions. The literature on real exchange rates, regional competitiveness, and currency unions is also limited. A notable study by Ca'Zorzi and De Santis (2004) examined the movements of regional real exchange rates, concluding that they are more pronounced in smaller countries. However, the literature on the relationship between regional competitiveness within a monetary union and the real exchange rate remains scant.

In this paper, we contribute to the ongoing debate on the measurement of competitiveness in the EMU by incorporating the territorial dimension. To this end, we develop a novel measure of regional real exchange rates as a proxy of regional competitiveness. This approach facilitates not only the examination of regional competitiveness but also a more comprehensive understanding of currency unions and real exchange rates. We analyse a sample of 127 Eurozone regions over the period 2003–2021 (which encompasses phases of robust economic growth as well as slowdowns caused by the global financial crisis, the pandemic of 2020, and other events). By integrating geographical and spatial analysis concurrently, our findings underscore two salient insights. First, we observe a geographical distribution of the real exchange rate, indicating that regional competitiveness is not only unevenly distributed across EMU regions but also evolves over time. Secondly, we identify spatial dependence, indicating that the competitiveness of a specific region is influenced by that of neighbouring regions. This dependence underscores the close clustering of regions with similar levels of competitiveness but ignores the possibility of neighbouring regions having different levels of competitiveness.

The remainder of this manuscript is structured as follows. Section 2 sketches the theoretical framework and the literature review. Section 3 describes the research hypotheses to be tested, while section 4 is focused on the empirical analysis. Section 5 shows the main results and, finally, section 6 summarizes the conclusions.

2. Theoretical framework

2.1. How to measure global competitiveness: further caveats

The World Competitiveness Ranking by the Institute for Management Development (IMD) is considered to be the benchmark for measuring international competitiveness. It includes approximately 330 elements

grouped into four categories: economic performance, government efficiency, infrastructure, and business efficiency. This methodology facilitates the integration of micro/business aspects of global competitiveness (IMD, 2020). However, the report lacks a regional perspective. A similar oversight is evident in the World Bank's Business Ready Index, which focuses exclusively on country-level assessments.

2.2. The analysis of national and regional competitiveness

There is no single definition of competitiveness in the academic literature. The early definitions focused on price factors. For Fagerberg (1988), a country's competitiveness was its ability to maintain an external trade surplus. From this perspective, the relevant factors are production costs and exchange rates. Similarly, Porter (1990) pointed out that the relevant factor is productivity growth.

Building on Porter's work, Esser et al. (1996) argued that competitiveness derives from actions at four interconnected levels: micro (firms), meso (industries and institutions), macro (economic policies), and meta (socio-cultural factors). From this perspective, what matters is the entire socio-economic system, not just companies and sectors. Chikān (2008) understood competitiveness as the ability to respond to changes in the economic environment. Competitiveness is thus a dynamic attribute, in contrast to the previous view that it is static.

For Krugman (1994), these concepts were misleading and dangerous. Competitiveness only makes sense at the company level, where winners succeed at the expense of losers. Competition between nations, however, is not a zero-sum game because trade benefits everyone. Therefore, the key for Krugman was productivity growth.

The transition to the knowledge economy gave rise to new definitions. For Lundvall (2007), competitiveness in the knowledge economy primarily depends on the capacity for learning and adaptation. This perspective emphasized the role of the institutional framework that supports interactive learning and innovation capacity. Meanwhile, Aiginger et al. (2013) defined competitiveness as the ability of a country (or region or location) to increase its citizens' welfare.

Thus, the concept of competitiveness is a contested issue, with no consensus among scholars. The debate remains open and extends to the definition of regional competitiveness.

According to Porter (2003), regional competitiveness is the productivity with which each region utilizes its natural resources and human capital. Storper (1997) related it to the ability to attract and maintain businesses while increasing people's standard of living. Huggins (2003) stated that it is the capacity to achieve greater economic growth than other regions with a similar level of development. Camagni (2002) defined it as the set of economic, cultural, and institutional assets and characteristics that enhance a region's development capacity. Aiginger and Firgo (2016) agree on the importance of institutional quality for regional competitiveness and also add education

and innovation capacity as relevant factors. Paola and Lewis (2013) defined regional competitiveness as the ability of a region to offer an attractive and sustainable environment for firms and residents to live and work in. More recent works have incorporated the concept of smart specialization (Foray et al., 2009; McCann and Ortega-Argilés, 2015). According to this perspective, regions must identify and develop distinct areas of comparative advantage based on their particular assets and capabilities. Hence, the lack of consensus about the definition persists.

2.3. The importance of regions: New Economic Geography and industrial concentration

The spatial distribution of economic activities and the concentration of industries within specific regions have long been central topics in economic geography. The advent of New Economic Geography (NEG) has furnished a robust theoretical framework for the analysis of regional development, industrial clustering, and spatial inequalities. This theoretical framework explores the importance of regions, drawing on key concepts and theories from NEG and related disciplines. The importance of regions, as highlighted by Storper (1997), lies in their capacity to foster economic growth and innovation by providing specialized resources, infrastructure, and networks that attract and retain industries.

Krugman's (1991) Core–Periphery Model is widely regarded as a foundational contribution in the field of NEG. It elucidates the genesis of regional disparities by clarifying the interplay between centripetal and centrifugal forces. Centripetal forces, such as agglomeration economies and market access, drive the concentration of economic activities in core regions. Conversely, centrifugal forces, such as congestion costs and rising factor prices, incentivize the dispersion of economic activity to peripheral regions. This theoretical framework underscores the self-reinforcing nature of regional concentration and its impact on spatial inequalities.

Marshall's (1890) study, which can be considered as a seminal contribution to economics, identified three primary drivers of agglomeration economies. The first is knowledge spillovers, given that proximity facilitates the exchange of ideas and innovation. The second is labour market pooling, as firms located in specific regions offer a specialized workforce, reduce hiring costs, and improve labour matching. Thirdly, input–output linkages have been demonstrated to be advantageous for firms because they lead to proximity to suppliers and customers, thereby enhancing efficiency and reducing transaction costs. These factors create positive feedback loops that sustain industrial clusters and regional competitiveness.

Other seminal contributions, such as those of David (1985) and Arthur (1994), elucidated the pivotal role of historical contingencies and increasing returns in shaping regional development. Once a region attains a critical mass

of economic activity, it becomes "locked in" as a hub for specific industries, making competition challenging for other regions.

Furthermore, regions that have developed robust infrastructure and are connected to major markets experience higher levels of industrial concentration. For instance, transport networks have been shown to reduce transaction costs and facilitate the movement of goods, services, and labour (Venables, 1996). Innovation is also crucial, since ecosystems thrive in regions where firms, universities, and research institutions collaborate. Storper and Venables (2004) emphasized the "buzz" of cities, where face-to-face interactions and tacit knowledge exchanges drive creativity and innovation. In a broader context, globalization has redefined the importance of regions by integrating them into global value chains. Regions that function as nodes in these networks gain competitive advantages by leveraging their specialization and connectivity (Baldwin and Martin, 2004).

While the NEG model offers valuable insights, it is important to acknowledge its limitations. Critics contend that its models frequently oversimplify intricate regional dynamics by placing excessive emphasis on economic factors (Martin, 1999) and neglecting crucial aspects, such as path dependence or the specific factors that could contribute to explaining regional disparities (Martin and Sunley, 2011). Consequently, the development of metrics related to regional competitiveness could facilitate a more nuanced understanding of NEG, thereby enabling the extrapolation of findings from specific territories to the global economy.

2.4. The problem of measuring competitiveness

Early approaches to measuring competitiveness focused primarily on price and cost factors, reflecting the traditional view of competitiveness as essentially a matter of relative prices in international markets (Fagerberg, 1988). As conceptualizations of competitiveness broadened to include non-price factors, measurement approaches similarly expanded. However, price and cost measures remain widely used because of their relative simplicity and for reasons of data availability. The most common measures include:

- real effective exchange rates (REERs), which capture both nominal exchange rate movements and relative price changes, providing a comprehensive measure of price competitiveness (Turner and Van't dack, 1993);
- indicators based on unit labour costs (ULCs), which are particularly useful for assessing cost competitiveness in manufacturing and other labour-intensive sectors (Felipe and Kumar, 2014);
- export price indices offer direct insight into price competitiveness in international markets. However, they may reflect strategic pricing decisions rather than underlying cost structures (Neary, 2006).

- the World Competitiveness Ranking (WCR), which combines statistical data with executive opinion surveys (IMD, 2020); and
- the EU Regional Competitiveness Index (RCI), which assesses regional competitiveness using 74 indicators organized into 11 pillars (Annoni and Dijkstra, 2019).

The composite indices offer comprehensive assessments, but face criticism regarding their methodological transparency, indicator selection, weighting schemes, and the challenges of meaningful aggregation across diverse dimensions (Ketels, 2016). Additionally, measurement frameworks often encounter challenges related to data scarcity, the weighting of indicators, and the applicability to specific contexts. The lack of studies at the regional level that incorporate real exchange rates as a measure of competitiveness further underscores the necessity for enhanced academic research in this domain.

2.5. Unit labour costs as a measure of regional competitiveness

Both ULCs and REERs offer significant advantages as competitiveness indicators. They are both firmly grounded in economic theory. ULCs directly capture the relationship between labour compensation and productivity, which is central to cost competitiveness in many industries. REERs reflect the purchasing power parity theory and provide a comprehensive measure of price competitiveness. Data for calculating ULCs and REERs are available for most countries and over extended time periods.

A very important point is that these measures directly capture the price and cost aspects of competitiveness, which remain important determinants of trade flows and market shares, particularly in price-sensitive sectors and over shorter time horizons (Carlin et al., 2001).

Despite their advantages, ULCs and REERs are subject to several important limitations. ULCs focus exclusively on labour costs, ignoring other important aspects of competitiveness. REERs assume that all goods are tradable and subject to international price competition, which is increasingly unrealistic. Neither ULCs nor REERs adequately account for quality differences or non-price competitive factors.

Despite this criticism, ULCs and REERs have particular relevance for assessing competitiveness within the EMU. The defining feature of a monetary union is the irrevocable fixing of exchange rates between member states. This eliminates nominal exchange rate adjustments as a mechanism for correcting imbalances in competitiveness, increasing the importance of internal adjustment through relative costs and prices (Mundell, 1961; Estrada et al., 2013).

With monetary policy set by the European Central Bank for the euro area as a whole, individual member states cannot use interest rates or money supply to address country-specific competitiveness challenges. This places greater

emphasis on fiscal policy, structural reforms, and cost adjustments, which are directly reflected in ULC developments (Lane, 2006).

Compared to alternative competitiveness measures, ULCs and internal REERs offer particular advantages in the EMU context. In the absence of nominal exchange rate adjustment, internal devaluation primarily operates through relative labour costs and prices. ULCs directly measure these adjustment channels, making them more relevant than broader composite indices or productivity-only measures (Gabrisch and Staehr, 2015).

Many alternative competitiveness measures are designed primarily for global comparisons, rather than for assessing relative positions within a highly integrated economic area. ULCs and internal REERs are better suited for analysing relative competitiveness among countries at similar development levels operating within a single market and currency area (European Central Bank, 2012).

3. Research hypotheses

Since the introduction of the euro in 1999, economic disparities have become more pronounced among regions within the EMU. Core regions, such as Bavaria (Germany) and Île-de-France (France), have benefited from trade surpluses and strong industrial bases, whereas peripheral regions, including Andalucía (Spain), Calabria (Italy), and Eastern Macedonia and Thrace (Greece), have struggled with high unemployment and low productivity growth (Blanchard, 2007). The divergence is partially attributed to structural differences in economic specialization and the ability to adapt to global competition (Baldwin and Giavazzi, 2015). This fact leads us to propose a first hypothesis:

H1: There is an ongoing evolution of regional competitiveness within the European Monetary Union over time.

In a globalized context, the study of neighbouring effects in terms of competitiveness is of particular importance because of the implications of regional interactions and their spillover effects on the convergence and growth processes. The literature demonstrates that there is a greater propensity for more complex productive tasks to be diffused between neighbouring regions (Balland et al., 2020; Verheij and de Oliveira, 2020). This recent evidence serves to reinforce the fundamental tenets of Krugman's (1991) Core–Periphery Model. The generation of sophisticated products and services typically necessitates a skilled workforce and the establishment of knowledge transfer networks, for which consolidation is challenging. Despite the tendency of a more skilled workforce to escalate labour costs, the tasks performed by these workers often exhibit greater productivity and generate higher value-added, thereby potentially offsetting the increase in total costs. Consequently, despite the finding of Šlander and Ogorevc (2010) of a convergence process in nominal

labour cost within the European Union, it is anticipated that a pronounced spatial dependence between regions will emerge, with the most competitive regions tending to exhibit agglomeration effects. In this context, we propose our second hypothesis:

H2: Regional competitiveness is influenced by geographical patterns in the European Monetary Union.

4. Empirical analysis

4.1. How to estimate regional competitiveness via unit labour costs

We develop a novel measure of regional real exchange rates (RERs) as a proxy of regional competitiveness (Boundi-Chraki and Perrotini-Hernández, 2021). The RER, a bilateral measure between the currencies of two countries for the same basket of goods denominated in a common currency, is defined by the following relationship (Krugman et al., 2014; Poulakis and Tsaliki, 2023):

$$RER_{ct} = \frac{NER_{ct} \times P^{*}_{ct}}{P_{ct}} \quad (1)$$

where the subscripts *c* and *t* refer to country and time, respectively. NER_{ct} is the nominal exchange rate of one country expressed in the currency of another country. P_{ct}^{*} is the level of foreign prices, while P_{ct} refers to the level of domestic prices. The RER accounts for the relationship between the prices of a basket of goods and services in two different countries, considering the nominal exchange rate. It is important to note that the RER is not simply a currency conversion, since it reflects the relative competitiveness between one country and another.

The OECD (2022) real exchange rate expression is based on unit labour costs rather than price indices. The literature supports the association between unit labour costs and the real exchange rate (Boundi-Chraki, 2021; Shaikh and Antonopoulos, 2013). Unit labour costs (ULCs) have been calculated as set out in equation (2):

$$ULC_{ct} = \frac{LCHW_{ct}}{PPHW_{ct}} \times 100 = \frac{\frac{TLC_{ct}}{HW_{ct}}}{\frac{GVA_{ct}}{HW_{ct}}} \times 100 \quad (2)$$

where *LCHW* refers to Labour Cost per Hour Worked; *PPHW* is the Productivity per Hour Worked; *TLC* are the Total Labour Costs*; HW* is the number of Hours Worked and *GVA* is the Gross Value Added.

Finally, we use the same country formulations as above to calculate the RER and ULC for the different regions in the sample. In this case, the subscript *r* refers to the region. We therefore consider a new equation (3):

$$RER_{rt} = NER_{rt} \times \frac{ULC_{emu\,t}}{ULC_{rt}} \quad (3)$$

As the Eurozone regions share a common currency, there are no differences in terms of NER, so this can be assumed to be equal to 1, a fact that emphasizes the importance of considering the RER. In this context, the RER is measured as the quotient between the average unit labour cost of the EMU and the unit labour cost of each region. The higher the RER of a region, the higher the competitiveness of its economy in the euro area as a whole.

The importance of RER also requires us to identify which variables could be used as potential measures. In this study, we build our argument using labour productivity as the primary factor influencing ULCs. Regions with more dynamic, innovative, and technologically advanced economies tend to improve their productivity more rapidly than those reliant on traditional sectors (Rodríguez-Pose and Crescenzi, 2008). A rise in nominal wages exceeding a rise in productivity has been shown to result in an escalation in ULCs (Blanchard and Giavazzi, 2003). It has been alleged that regions characterized by more stringent labour markets or significant union pressure experience heightened increases in nominal labour costs (Blanchard and Giavazzi, 2003). Furthermore, disparities in infrastructure, human capital, and productive structures are foundational in the regional evolution of ULCs (Fagerberg et al., 1997). More importantly, labour costs can be associated with inflation differences, which can account for productivity differences in a currency union (Díaz-Roldán et al., 2018).

Another important issue is the evolution of competitiveness over time, since structural changes during globalization can affect labour markets (e.g., Autor et al., 2013), which can affect regional competitiveness. Therefore, a longitudinal analysis of regional competitiveness can be considered as a must, as the influence of these factors undergoes evolution across the business cycle. This influence implies that regional competitiveness may face an evolution over time, highlighting the importance of the business cycle. Real unit labour costs have been shown to exert a significant influence on real exchange rates, with their effects often being protracted, thereby potentially perpetuating or intensifying trade imbalances (Poulakis and Tsaliki, 2023).

4.2. Data and sources

In this study, we examine a sample of 127 EMU regions during the period 2003–2021. The regions exhibit sufficient heterogeneity, as they belong to all the three categories of regions established by the European Union for its regional policy: the most developed regions, with a GDP per capita above 90% of the EU average; the transition regions, with an income between 75% and 90% of the EU average; and the least developed regions, with an income below 75%. All variables were obtained from the regional statistics section of the Eurostat database. Table A2, located in the Appendix, presents the list of the 127 European regions used in the analysis. These regions belong to the initial twelve member states of the European Monetary Union that implemented the euro currency during its inaugural phase of adoption: Austria, Belgium, Finland,

France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Greece, and Spain. Given the utilization of a single explanatory variable, the descriptive statistics have undergone disaggregation by year to elucidate the fluctuations in the real exchange rate over time, as shown in Table A1 (see Appendix).

According to Table A1, the average value of the real exchange rate index in the EMU remained relatively stable over the period 2003-2021. A modest enhancement in competitiveness was observed during the Great Recession period, which is primarily attributable to the internal devaluation manifested as a reduction in labour costs, and this was followed by a slight decline in competitiveness during the ensuing economic recovery. However, a notable widening in the range between the maximum and minimum values of the index can be observed, particularly in the later years. While the standard deviation remained relatively stable over time, a discernible gap emerged between the most and least competitive regions, suggesting potential disparities in economic performance and resilience. If this trend persists in the medium and long term, disparities in terms of convergence could become substantial.

4.3. Methodological approach: Geographical and spatial analysis

For this analysis, we adopt a twofold methodological approach that combines Geographical Information Systems (GIS) and spatial economic analysis. First, we utilize a GIS approach, which enables us to plot variables by incorporating the territorial dimension through maps (Burrough et al., 2005). It has been argued that mapping is playing a crucial role in revitalizing development economics, as it provides a more finely-grained analysis of territorial inequalities (Vázquez-Barquero and Rodríguez-Cohard, 2020). Specifically, GIS can capture within-country differences in global competitiveness, offering valuable insights to test the first research hypothesis.

Second, we employ spatial analysis, which has proved to be particularly effective in explaining spatial dependence since Anselin's seminal work (1988). Spatial dependence can be defined as an exploratory measure that assesses how the outcome for a specific region can be influenced by the outcome for neighbouring regions and hence may capture the existence of spillover effects. To test the potential existence of spatial dependence, we follow the most widely used approach, Moran's (1950) *I* test. The specific calculation of the Global Moran's *I* test is shown in equation (4):

$$I = \frac{N}{\sum_i \sum_j w_{ij}} X \frac{\sum_i \sum_j w_{ij}(x_i-\bar{x})(x_j-\bar{x})}{\sum_i (x_i-\bar{x})^2} \quad (4)$$

$$S_i^2 = \frac{\sum_{j=1,\, j\neq 1}^{n} (x_j-\bar{x})^2}{n-1} \quad (5)$$

where the subscript i refers to the location, x_i to the attribute and $\bar{x}$ to the simple average of the attribute, and w_{ij} is the spatial weight given to i in relation

to another location j. Following Anselin (1988), the w_{ij} can be interpreted as the cells of a weighting matrix W with dimensions (n x n), where n refers to the total number of locations considered. The weight w_{ij} is equal to 1 if i and j are adjacent, and is 0 otherwise. This matrix is standardized to obtain a relative measure of spatial dependence rather than an absolute one, which helps to make results comparable across different regions. Therefore, I_i denotes Moran's index for location i.

The interpretation of Moran's test is similar to that of a statistical correlation coefficient, as its values range between -1 and 1. Values greater than 0 indicate positive spatial autocorrelation, where high values are surrounded by high values, and low values are surrounded by low values. In contrast, negative values suggest negative spatial autocorrelation, where high values are surrounded by nearby low values, or low values are surrounded by nearby high values. Finally, values close to 0 indicate no spatial autocorrelation in the data. Using Moran's *I* test, we can identify or reject the presence of spatial dependence in the measure of regional competitiveness, which helps to confirm or reject the second research hypothesis *H2*.

To strengthen the results from Moran's test, the Geary C test (Geary, 1954) is employed. In contrast to Moran's test, Geary's test exhibits heightened sensitivity to local variations by accentuating differences between adjacent regions. According to Bivand and Wong (2018), the equation for Geary's test is expressed as follows:

$$C=\left(\frac{N-1}{2\sum_i\sum_j w_{ij}}\right) X \frac{\sum_i\sum_j w_{ij}(x_i-x_j)^2}{\sum_i(x_i-\bar{x})^2} \quad (6)$$

The value of C in Geary's C test ranges between 0 and 2. A value of C less than 1 denotes positive spatial autocorrelation, indicating that similar values cluster together. Conversely, a value greater than 1 denotes negative spatial autocorrelation, suggesting that dissimilar values are adjacent.

5. Results

5.1. First research hypothesis

First, we analyse the geographical pattern of the regional real exchange rate by presenting two maps, one for the beginning and one for the end of the time period. Figures 1 and 2 display the maps for 2003 and 2021, respectively. Comparing these two dates allows us to examine whether the geographical pattern changed over time or remained stable.

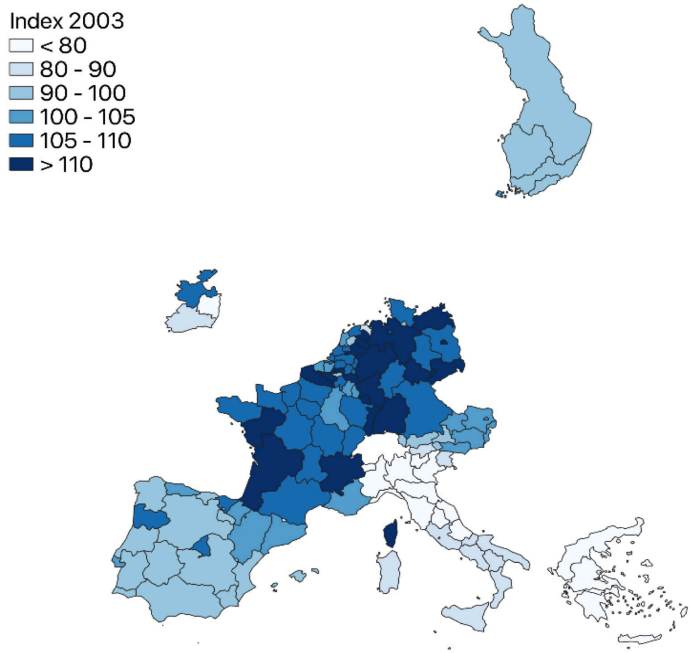
The regions that lost the most relative competitiveness are located in Ireland (Southern, Eastern and Midland, and Northern and Western), Portugal (Madeira), Italy (Basilicata), Belgium (Bruxelles-Capitale and Antwerpen) and Netherlands (Limburg and Zeeland). Conversely, the regions that experienced the greatest increases in relative competitiveness are located in Greece (Voreia Ellāda, Nisia Aigalou and Kentriki Ellāda), the Netherlands (Groningen),

Germany (Hamburg), Italy (Umbria, Veneto, Marche, Piemonte and Liguria) and Spain (Región de Murcia).

It is also interesting to analyse the changes in the relative position of countries during the period. German regions continue to exhibit the highest levels of competitiveness, which is not surprising because of their strong export performance (Garzón Espinosa and Fernández Sánchez, 2016). France remains the country with the second-highest number of regions among the most competitive ones. In 2021 Madrid ranked among the fifteen top-performing regions, whereas at the outset of the period it occupied an intermediate position. In Spain, apart from Comunidad de Madrid, other regions such as Cataluña, Canarias, Región de Murcia and Andalucía improved their positions.

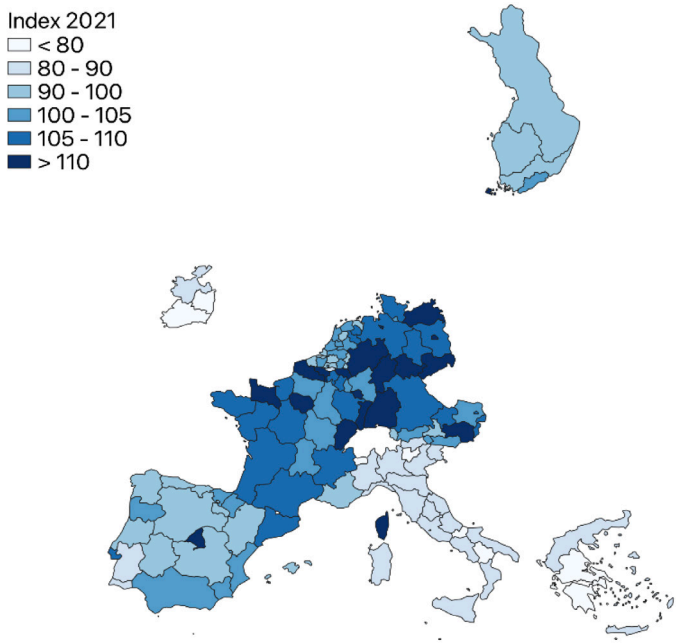
The Italian, Greek and Irish regions remained among the least competitive. However, the evolutions of these countries were different over time, highlighting the key role of structural analysis: the four Greek regions in the study occupied the lowest positions in 2003, but as time went on they improved their positions, and this is especially the case for Voreia Elláda. In 2021, two Irish regions had the lowest competitiveness values in the sample (Southern, and Eastern and Midland), although the Northern and Western regions had made significant

Figure 1. Spatial distribution of the real exchange rate for European regions, 2003



Source: Elaborated by the authors.

Figure 2. Spatial distribution of the real exchange rate for European regions, 2021



Source: Elaborated by the authors.

progress. Each of the Italian regions evolved in a different way. Basilicata, which initially started with the highest competitiveness index, lost significantly in competitiveness. This region went from leading the country to having the third worst value at the end of the period. Calabria, which was initially the second most competitive Italian region, experienced very similar behaviour. In this order, Friuli-Venezia Giulia, Lazio and Piemonte manage to position themselves with the best real exchange rate indices.[1]

The Dutch regions lost ground over time. Although the Groningen region (the worst positioned in 2003) significantly improved, two former European benchmarks (Overijssel and Drenthe) were no longer found among the top positions. In Portugal, the loss of leadership of the Madeira in favour of Grande Lisboa, which is moving nearer to the group of regions with the highest indices at EMU level, is evident. Belgium also experienced significant changes. The region of Bruxelles-Capitale was the third most competitive in the euro area at the beginning of the period. However, in 2021 it was no longer in the group

1 The academic literature has highlighted the role of a profound North–South divide for the Italian regions (e.g., González, 2011).

of the 20 best-positioned regions. Although they also seem to have lower positions, the regions of Hainaut and Liège continued to show high values for competitiveness. The Austrian regions improved their situation in general terms. Steiermark was still the best performer, but it moved from 62nd to 22nd position. The Wien region also climbed more than forty positions. Tirol (the least competitive) and Oberösterreich moved up around thirty positions overall.

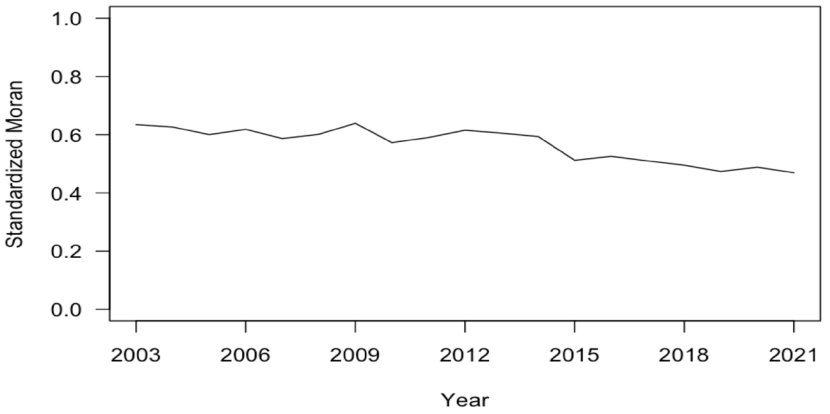
Therefore, these results are in line with the first research hypothesis *H1*, since there is a clear evolution in regions' competitiveness over time.

Finally, when comparing the centre and the periphery, it is evident that the peripheral regions remain the least competitive, despite the disparities having reduced, because their economic structure is based on traditional and labour-intensive sectors.

5.2. Second research hypothesis

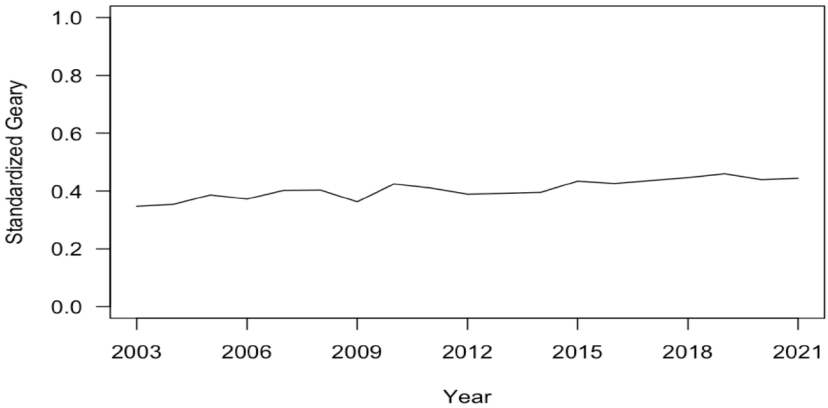
To answer the second research hypothesis *H2*, we use Moran's *I* test and Geary's C test. Figure 3 shows that the values of Moran's *I* range between 0.5 and 0.6, indicating positive spatial dependence. This suggests that regions with lower exchange rates tend to be surrounded by regions with similarly lower exchange rates, while a similar pattern is observed for higher exchange rates. Moreover, the values slightly decrease over time, implying that spatial dependence remains significant but is gradually weakening. However, no significant changes are observed after the pandemic. Geary's C test confirms the results of Moran's *I* test, since C falls within the range of 0.3 to 0.4, with an increasing trend over the period (see Figure 4).

Figure 3. Moran's I test values, 2003 – 2021



Source: Elaborated by the authors.

Figure 4. Geary's C test values, 2003 – 2021



Source: Elaborated by the authors.

These results align with the second research hypothesis *H2,* as spatial dependence is evident. Figures 1 and 2 show that, with some exceptions, the most competitive regions are still concentrated in central and northern Europe, while the least competitive are situated in the south. This finding can be explained using Krugman's (1991) core–periphery framework: core regions with higher competitiveness, driven by industrial location, tend to be surrounded by other core regions, while a similar pattern is observed for peripheral regions with lower competitiveness. Consequently, the existence of spatial spillovers between regions with high and low competitiveness is not observed.

6. Discussion, conclusions and further research

Although there is still strong agglomeration between the regions in terms of competitiveness, the time evolution shown by Moran's and Geary's tests indicates that this relationship has been gradually losing strength. Current trends suggest that a significant part of future growth will come from the services sector, in which activities tend to be concentrated in large and prosperous cities (Draghi, 2024). This may, for instance, explain why certain regions have made significant progress in their competitiveness in recent years without there necessarily having been similar developments in bordering regions. Table 1 shows the real exchange rates in 2003 and 2021, and the relative position, in terms of competitiveness in the EMU as a whole, of Comunidad de Madrid, Grande Lisboa and Wien compared to their respective neighbouring regions. Despite the strength of these three regions, it can be observed that the bordering regions have very similar values and positions in both years. In addition to the aforementioned cases, regions traditionally

characterized by high competitiveness, particularly those encompassing major capitals such as Île de France (Paris), Bayern (Munich) and Berlin, persist with their competitive status (and even climb up the ranking). In the paradigm of the knowledge economy, large cities offer extraordinary opportunities for learning, exponentially accelerating the development of human capital due, among other reasons, to the greater interaction between highly skilled individuals and a higher concentration of technology-intensive companies, making them magnificent incubators of companies that generate a powerful impact on labour productivity (Gómez Tello et al., 2025). For this reason, it would be important to analyse the growth dynamics and development of the sectors in these cities in greater depth, given the importance of urban growth derived from density in recent years (Duranton and Puga, 2023). This could have important implications for industrialization policies (García and Fernández, 2021).

Table 1. Comparison of the real exchange rate index with bordering regions

NUTS (2021 Code)	Region	2003		2021	
		Index	Position	Index	Position
PT16	Centro	97.86	80	95.57	87
PT18	Alentejo	90.55	99	89.83	97
PT17	*Grande Lisboa*	*101.85*	*68*	*106.93*	*34*
ES41	Castilla y Leõn	93.70	92	94.56	91
ES42	Castilla-La Mancha	93.23	95	95.25	89
ES30	*Comunidad de Madrid*	*107.07*	*44*	*112.58*	*13*
AT12	Niederösterreich	100.52	73	101.54	65
AT13	*Wien*	*101.46*	*70*	*108.98*	*26*

Source: Elaborated by the authors.

The political implications of this are immediate. First, this article demonstrates the importance of continuing to use unit labour costs and real exchange rates as a measure of regional competitiveness and to give an understanding of the reality of regions within a monetary union. The information these measures provide can be complemented with insights from composite indicators, such as the EU's RCI. Second, our index highlights the persistence of the lag for peripheral regions, as well as the possibility of an increase in inequality between peripheral regions and major metropolitan areas, where competitiveness is higher and growing faster. This represents a challenge for the regional policy of the European Union and its Member States. Finally, it should be noted that the greater competitiveness of major metropolitan areas attracts companies and workers. This presents many opportunities, but also significant challenges in terms of urban management and socio-economic inequality within these areas.

We confirm the importance of moving from global to regional issues when examining competitiveness, which leaves room for important policy implications. The dynamics of regional competitiveness vary over time, but

neighbouring effects remain, given the results of Moran's and Geary's tests for spatial dependence. As industrial activity is concentrated in specific areas (Krugman, 1991), policies are progressively moving towards regional clustering (Delgado et al., 2010; Enright, 2000). As differences between core and peripheral regions increase because of regional competitiveness asymmetries, it is crucial to be cautious, since lower competitiveness can be associated with lower economic decline because agglomeration forces are left aside (Rodrīguez-Pose, 2018). More importantly, lack of competitiveness could be contributing to an increase in the so-called development trap (Diemer et al., 2019). In this sense, institutions and the public sector could be crucial in fostering economic development via reindustrialization, as recently shown by the Draghi (2024) and Letta (2024) reports. One should not overlook the fact that the new industrialization policies seem to depend strongly on the sectors considered and the socio-environmental context (García and Fernández, 2021).

This manuscript also offers interesting avenues for future research. First, it would be useful to shed light on explanatory factors beyond regional competitiveness and to explore alternative measures beyond exchange rates. Second, this analysis could be extended to other monetary unions, with a special emphasis on developing countries (Cooper, 2014), since their labour costs tend to be lower and they are acquiring a growing importance in the context of globalization.

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Appendix

Table A1. Real Exchange Rate (RER). Main descriptive statistics sorted by year

Year	Mean	Std. dev.	Min	Max
2003	99.17	12.90	67.22	121.22
2004	99.60	12.56	68.42	119.88
2005	99.78	11.99	71.46	118.66
2006	99.95	11.57	71.78	119.59
2007	100.34	11.49	72.62	120.42
2008	100.43	11.39	69.34	123.18
2009	100.28	11.26	72.72	120.94
2010	100.46	11.49	74.30	121.80
2011	100.52	11.57	73.40	122.33
2012	99.52	12.31	71.65	117.85
2013	99.21	12.74	70.39	118.67
2014	98.96	12.64	72.02	118.97
2015	98.95	13.34	69.73	120.02
2016	98.50	12.78	71.82	119.64
2017	98.30	12.84	70.26	119.44
2018	98.32	12.82	64.19	118.10
2019	98.48	12.61	63.48	120.53
2020	98.99	12.60	58.90	123.20
2021	99.05	12.69	59.14	123.79

Source: Own elaboration based on Eurostat.

Table A2. List of NUTS 1 and NUTS2 codes for regions used in the analysis[2]

AT11 (Burgenland)	DED (Sachsen)	FR10 (Ile-de-France)	ITG1 (Sicilia)
AT12 (Niederösterreich)	DEE (Sachsen-Anhalt)	FRB0 (Centre-Val de Loire)	ITG2 (Sardegna)
AT13 (Wien)	DEF (Schleswig-Holstein)	FRC1 (Bourgogne)	ITH1 (Prov.Aut.Bolzano)
AT21 (Kärnten)	DEG (Thüringen)	FRC2 (Franche-Comtê)	ITH2 (Prov.Aut.Trento)
AT22 (Steiermark)	EL3 (Attiki)	FRD1 (Basse-Normandie)	ITH3 (Veneto)
AT31 (Oberösterreich)	EL4 (Nisia Algalou, Kriti)	FRD2 (Haute-Normandie)	ITH4 (Friuli-Venezia Giulia)
AT32 (Salzburg)	EL5 (Voreia Elláda)	FRE1 (Nord-Pas de Calais)	ITH5 (Emilia-Romagna)
AT33 (Tirol)	EL6 (Kentriki Elláda)	FRE2 (Picardie)	ITI1 (Toscana)
AT34 (Vorarlberg)	ES11 (Galicia)	FRF1 (Alsace)	ITI2 (Umbria)
BE10 (Bruxelles-Capitale)	ES12 (Principado de Asturias)	FRF2 (Champagne-Ardenne)	ITI3 (Marche)
BE21 (Antwerpen)	ES13 (Cantabria)	FRF3 (Lorraine)	ITI4 (Lazio)
BE22 (Limburg)	ES21 (País Vasco)	FRG0 (Pays de la Loire)	LU00 (Luxembourg)
BE23 (Oost-Vlaanderen)	ES22 (Comunidad Foral de Navarra)	FRH0 (Bretagne)	NL11 (Groningen)
BE24 (Vlaams-Brabant)	ES23 (La Rioja)	FRI (Nouvelle-Aquitaine)	NL12 (Friesland)
BE25 (West-Vlaanderen)	ES24 (Aragón)	FRJ (Occitanie)	NL13 (Drenthe)
BE31 (Brabant wallon)	ES30 (Comunidad de Madrid)	FRK1 (Auvergne)	NL21 (Overijssel)
BE32 (Hainaut)	ES41 (Castilla y León)	FRK2 (Rhône-Alpes)	NL22 (Gelderland)
BE33 (Liège)	ES42 (Castilla-La Mancha)	FRL0 (Prov.Alpes-Côte d'Azur)	NL23 (Flevoland)
BE34 (Luxembourg)	ES43 (Extremadura)	FRM0 (Corse)	NL31 (Utrecht)
BE35 (Namur)	ES51 (Cataluña)	IE04 (Northern and Western)	NL32 (Noord-Holland)
DE1 (Baden-Württemberg)	ES52 (Comunitat Valenciana)	IE05 (Southern)	NL33 (Zuid-Holland)
DE2 (Bayern)	ES53 (Illes Balears)	IE06 (Eastern and Midland)	NL34 (Zeeland)
DE3 (Berlin)	ES61 (Andalucía)	ITC1 (Piemonte)	NL41 (Noord-Brabant)
DE4 (Brandenburg)	ES62 (Región de Murcia)	ITC2 (Valle d'Aosta)	NL42 (Limburg)
DE5 (Bremen)	ES63 (Ciudad de Ceuta)	ITC3 (Liguria)	PT11 (Norte)
DE6 (Hamburg)	ES64 (Ciudad de Melilla)	ITC4 (Lombardia)	PT15 (Algarve)
DE7 (Hessen)	ES70 (Canarias)	ITF1 (Abruzzo)	PT16 (Centro)
DE8 (Mecklenburg- Vorpornmern)	FI19 (Länsi-Suomi)	ITF2 (Molise)	PT17 (Grande Lisboa)
DE9 (Niedersachsen)	FI1B (Helsinki-Uusimaa)	ITF3 (Campania)	PT18 (Alentejo)
DEA (Nordrhein-Westfalen)	FI1C (Etelä-Suomi)	ITF4 (Puglia)	PT20 (Reg.Aut.Açores)
DEB (Rheinland-Pfalz)	FI1D (Pohjois-ja Itä-Suomi)	ITF5 (Basilicata)	PT30 (Reg.Aut.Madeira)
DEC (Saarland)	FI20 (Åland)	ITF6 (Calabria)	

Note 1: NUTS1 and NUTS2 refer to the Nomenclature of Units for Territorial Statistics (NUTS), which is a hierarchical territorial system developed by the European Union for statistical and administrative purposes.

2 The first two letters of the NUTS code indicate the country of each region. All the regions in our sample are in the founding countries of the euro (with the exception of Greece, which began using the single currency in 2001). Therefore, during the period under analysis (2003–2021), all the countries were part of the eurozone: AT (Austria), BE (Belgium), DE (Germany), EL (Greece), ES (Spain), FI (Finland), FR (France), IE (Ireland), IT (Italy), LU (Luxembourg), NL (Netherlands), and PT (Portugal).