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Regional Pathways to Internationalization: The Role of Erasmus+ in European HEIs

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Abstract: This study examines the geographic distribution of Erasmus+ incoming student mobility across European Higher Education Institutions (HEIs) from 2014 to 2020, highlighting significant regional disparities. It addresses the crucial questions of how regional and institutional factors influence student attractiveness and the emerging hotspots of mobility, which are vital for understanding the dynamics of educational internationalisation and regional development. The primary goal of this work is to identify the regional and institutional determinants of Erasmus student mobility and to propose strategies for enhancing the attractiveness of less favoured regions. Employing hotspot analysis and a two-level random intercept model, this research analyses spatial patterns and the influences of regional characteristics and institutional variables on Erasmus mobility rates. The findings reveal that while Spain, Germany, and the UK are leading recipients of Erasmus students, significant mobility hotspots exist primarily in Spain, Portugal, and southern France, with unexpected clusters emerging in Ireland and Sweden, indicating evolving dynamics in student mobility patterns. The conclusions underscore the importance of targeted regional policies to enhance HEI attractiveness and promote balanced internationalisation across Europe, particularly in underserved areas. These findings call for strategic interventions that align with broader regional economic goals, ensuring that the benefits of the Erasmus+ programme are distributed more equitably. Ultimately, this work contributes to the existing body of knowledge by providing empirical insights into the factors shaping Erasmus+ mobility, informing policymakers and educational institutions about the potential for fostering regional development through enhanced internationalisation.

Keywords: Erasmus+; student attractiveness; Erasmus flow; hotspot analysis; multilevel analysis; regional random effects; internationalisation

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1. Introduction

How can European regions benefit from the tremendous movement of over 280,000 Erasmus students annually, involving more than 2000 Higher Education Institutions (HEIs)? This paper investigates the regional distribution of Erasmus+ incoming student mobility from 2014 to 2020 and explores how regional and institutional factors influence the attractiveness of HEIs to these students. Using hotspot analysis and multilevel modelling, it identifies spatial patterns, such as the emergence of unexpected hotspots in Ireland and southern Sweden. It examines the roles of regional characteristics like education attainment, research capacity, and employment prospects. The research reveals significant spatial disparities, with hotspots concentrated in Spain, Portugal, and parts of France, despite large overall numbers in countries like Germany and the UK. This work is vital for understanding

how Erasmus+ fosters regional development and internationalisation, offering insights for policymakers and academic institutions to balance mobility flows, address regional inequalities, and harness the programme's potential for sustainable regional growth.

Despite its importance, research on the geography and regional dimensions of Erasmus+ mobility remains sparse and fragmented [1]. Existing studies have identified several factors influencing student mobility, such as urbanisation levels, the regional economy, and employment opportunities in host regions. Urban areas with abundant cultural and social amenities tend to attract more students, but factors like high living costs may deter some [2]. Research has also shown that regions with higher concentrations of tertiary-educated graduates and strong research outputs appeal more to Erasmus students. However, less attractive areas often face challenges like poor governance or economic stagnation, making it harder to draw international students. Some studies argue that country-level characteristics, such as national policies and institutional quality, can outweigh regional factors in driving mobility [3]. Much research has focused on national trends, leaving regional dynamics underexplored.

The research identifies several unsolved issues, including the fragmented understanding of what spatial clusters ("hotspots") of Erasmus mobility emerge and evolve and their spatio-temporal dynamics. While statistical analyses reveal where clusters form, they do not explain why certain regions outperform others. The formulated clusters are significant for proactive regional development strategies considering geopolitical changes like Brexit or COVID-19, which can reshape mobility trends. This lack of clarity is substantial because it hinders the ability of policymakers and institutions to design targeted interventions that could address regional disparities and promote balanced internationalisation. If these issues remain unresolved, the consequences could include perpetuating inequalities in access to the benefits of Erasmus+ mobility, such as economic growth, cultural integration, and innovation, particularly in "left-behind" regions [4]. Thus, the ineffective allocation of resources and missed opportunities to strengthen cohesion and competitiveness across Europe are possible, with detrimental effects that can exacerbate socioeconomic divides and undermine the broader goals of the Erasmus+ programme and EU cohesion policies.

This paper seeks to address the issue of uneven geographic distribution and regional disparities in Erasmus+ student mobility by exploring the geography of mobility and the factors influencing student mobility patterns and their implications for regional development and HEI internationalisation. The work develops and tests three hypotheses which examine how Erasmus+ mobility forms distinct spatial clusters of HEIs based on incoming student numbers and ratios, influenced by location, institutional traits, and regional socioeconomic and educational factors. The study uses data from the ETERO database, Eurostat, and other sources. It employs hotspot analysis to identify spatial clusters and a multilevel random intercept model to measure the effect of regional and institutional predictors. The study reveals the expected traditional mobility hubs in Spain and Portugal, the unexpected hotspots in Ireland and Sweden, and the surprising cold spots in countries like Poland and Germany. The study highlights the importance of HEI teaching loads, research intensity, regional educational attainment, and employment opportunities in driving mobility. Spatial inequalities in higher education attractiveness across Europe call for targeted policies to balance internationalisation. Analysing regional factors like graduate density, employment, research activity, and urban amenities shows how universities drive regional development. The results advocate strengthening these factors in disadvantaged areas to boost economic stability, innovation, and cultural integration. Aligning Erasmus+ flows with cohesion policies and local strategies is key to urban development and building competitive, sustainable urban environments.

The following section, "Literature, Data, Methods and Hypotheses", briefly reviews the literature, presents the data used in this work and the methods, especially multilevel analysis, and concludes by introducing the hypotheses to be tested. Section 3 presents the results, starting from the 2014–2020 geography of Erasmus incoming mobility, continuing to the results of the various multilevel models and concluding on the tested hypotheses. Section 4 discusses the results and concludes with policy recommendations relevant to academic research.

2. Literature, Data, Methods, and Hypotheses

2.1. Literature Review

International student mobility drives education, global collaboration, and labour market needs while supporting cultural and economic goals. Geopolitical factors like nationalism, immigration policies, Brexit, and economic shifts have altered student flows, boosting destinations like Canada, Australia, and Europe [5]. Research spans movers' characteristics, institutional policies, and regional impacts, highlighting how regional development shapes mobility [6].

The Erasmus+ programme is the flagship EU initiative to enhance human resources and promote sustainable development through education, training, and youth activities. It focuses on inclusivity, digital skills, and environmental sustainability while addressing socioeconomic challenges across Europe and internationally. Erasmus+ addresses three key actions: the mobility of individuals, cooperation among organisations and institutions, and support for policy development and cooperation [7]. The programme emphasises creating equitable opportunities, addressing systemic barriers, and integrating sustainability into education and training, making it a cornerstone for advancing EU priorities in education, innovation, and climate action [8]. Erasmus+ fosters regional development by addressing educational, social, economic, and environmental challenges, empowering underserved areas through education, innovation, and collaboration. It promotes inclusion and diversity, expanding access to education, training, and mobility for individuals in rural, remote, and economically disadvantaged regions. The programme supports strategic projects in sustainable growth, including rural development, to build competencies for long-term progress [4]. Through cooperation among organisations and institutions, Erasmus+ strengthens networks between local, regional, and international entities, modernising education systems, enhancing management capacities, and fostering innovative approaches [9–11]. Skills development improves employability [12,13] and wages [14], contributing to economic stability and reducing regional disparities. Additionally, student mobility strengthens regional and national [15] and European identity, fostering intercultural dialogue and reinforcing the "Erasmus effect" on cohesion and community integration [16].

Many researchers recognised the potential effects of Erasmus+ on regional development in terms of positive human capital flows and cultural integration. Thus, they examined the effect of places in attracting Erasmus students to improve local territories' civic engagement, hence widening the programme's impact. Researchers [1] Ref. identified a series of regional determinants of Erasmus mobility in European regions, including urbanisation levels, the presence of capital cities, the quality of governance, regional tourism activity, and the development trap status of regions, especially those in a development trap or at high risk of falling into one. Thus, urban, competitive, well-governed destinations receive more students, while less attractive regions struggle due to poor growth trajectories and governance issues. Researchers examined country characteristics and found them more significant than HEI characteristics in driving the internationalisation of academic staff [3]. Research-oriented HEIs in more attractive countries tend to have a higher share of international staff, while similar HEIs in less attractive countries experience limited

internationalisation. Thus, less attractive countries should focus on internal factors such as training and career opportunities for national researchers rather than trying to replicate the strategies of more attractive countries.

Significant research carried out by the Joint Research Centre (JRC) of the European Union [2] examined the effect of characteristics at the HEI and regional levels on the mobility of Erasmus students in the period 2007–2013. They provided a comprehensive account of variables that can reflect "regional attractiveness" across 142 NUTS2 regions and 26 EU Member States. The authors considered the effects of "Urbanisation", "Employment Opportunities", and the "Quality of the Education System". The degree of urbanisation was determined by the population density and thought of as either influencing student mobility negatively, as a proxy for higher living costs impacting degree mobile students more, or positively, as an indicator of urban lifestyle and local amenities with urban areas offering abundant cultural, social, and recreational opportunities more likely to attract more mobile students. Employability abroad and employment opportunities are reflected in the employment rate of recent tertiary graduates and expected earnings, which positively influence student mobility by signalling better job prospects and economic opportunities at the destination. The quality of the regional educational system is reflected in the percentage of universities in a region included in quality rankings such as the Times Higher Education (THE) rankings or a higher share of the population aged 30–34 with tertiary education. The latter also serves as a proxy for an educated population, fostering a peer effect that enhances the region's appeal to students. The study found that only two regional-level variables exerted statistically significant effects: the employment rate of recent tertiary graduates and the regional tertiary educational attainment.

2.2. Data

The data used in this work come from a variety of databases. The European Tertiary Education Register (ETER) Consortium, a cooperative effort that makes data about Higher Education Institutions (HEIs) throughout Europe publicly available, maintains the ETER, the central database. The ETER database provides all the HEI-specific data, including Erasmus mobility data at different study levels of the International Standard Classification of Education (ISCED). ISCED Levels 5 to 8 represent higher education and participate in HEI Erasmus+ mobility activities. Level 5 covers short-cycle tertiary education (e.g., associate degrees), Level 6 corresponds to bachelor's or equivalent, Level 7 to master's or equivalent, and Level 8 to doctoral or advanced research qualifications. The ETER also includes data and information on research and research programmes carried out by the HEIs. Data on publications are from the Centre for Science and Technology Studies (CWTS) Leiden Ranking 2024 based on bibliographic data from the Web of Science database produced by Clarivate. Regional data are drawn from Eurostat, especially the "Regional statistics by NUTS classification (reg)" section. Georeferencing of HEIs was derived by [10] and European Union administrative boundaries from the "Geographic Information System of the Commission".

We define two variables that show an HEI's position towards internationalisation. First, the average annual number of Erasmus incoming students to an HEI as the average of all reported incoming students by the HEI to ETER in the period. Second, the average rate of incoming Erasmus students is the ratio of the average number of incoming Erasmus students to the average number of the HEI's registered students in the period under consideration. The first indicator shows the scale of the incoming flow of Erasmus students and, inevitably, is related to the size of the HEI. The incoming rate indicator is related to the HEI's capacity to receive students and shows the intensity by which the Erasmus "spirit" is developed, irrespective of the HEI's size. At the HEI level, research [2] outlined several

factors that define three dimensions of the institutional attractiveness of HEIs, namely, teaching quality, research capacity, and institutional reputation. Teaching quality includes measuring the student–teacher ratio to reflect the teaching load and the fees paid per student at the host institution as a quality signal. Research capacity refers (a) to research intensity and compares the number of PhD graduates to graduates at lower ISCED levels and (b) to research excellence captured by the number of publications and their citations in the top 10% of most frequently cited articles. The JRC study captured institutional reputation using the Times Higher Education (THE) World University Rankings, with institutions included in this ranking expected to attract more mobile students due to their perceived prestige [2]. This work does not use the THE rankings because many participating institutions are not included. Thus, such a zero-inflated variable can cause significant problems, including biased estimates, inefficient inference, and model misspecification. Instead, we capture reputation among the academic community with the number of EU projects per 100 members of the HEI staff. The heterogeneity among HEIs can be partly controlled by variables capturing the HEIs' size measured by the total number of students enrolled in all ISCED levels, their legal status, and primarily if they are classified as public, private, or government-dependent, as well as by if their spatial location is in one place, or they are developing satellite campuses in different areas.

The reader should know that Erasmus's mobility from 2014 to 2019 faced constraints for two reasons. First, the agreements among the sending and hosting universities can limit students' choices. The flow of students was determined by the existing agreements, which are always numerous to cover many types of HEIs and destinations and, thus, do not constitute a significant obstacle to free movement. Second, Erasmus agreements refer to the yearly number of mobile students, which is capped. Hence, some individuals may face challenges in finding a suitable host institution, and the choices available may be a barrier to moving. However, there is no clear empirical evidence that Erasmus+ students broadly experience a lack of free choice due to their inability to be placed in their first-choice institution [12]. In addition, empirical evidence shows that it is relatively uncommon to establish entirely new cooperations as part of Erasmus+, given the long history of international collaboration in Europe. Hence, while Erasmus+ agreements form a basis for cooperation, they do not overly restrict student mobility choices, especially since these partnerships build on and complement existing collaborations rather than replace them [12].

As outlined [2], geographical factors contributing to regional attractiveness for student mobility include urbanisation, regional employment opportunities, the region's capacity to support graduates, and the quality of the regional educational system. Urbanisation, in the sense of high population density, can play a double role in deterring or attracting students. The former may be due to higher living costs, including rent and food, and the latter to the urban lifestyle and amenities. Higher regional employment rates for recent tertiary graduates and higher expected earnings can be more attractive to Erasmus students who may seek to remain or return to the host country after graduation to pursue employment. Regions with a higher proportion of tertiary-educated graduates are seen as more attractive due to the potential for peer effects and a more skilled population that attracts businesses. Finally, the quality of the regional tertiary education system is reflected in the regional academic publication record of the hosting institutions of the region. These factors can collectively shape Erasmus students' decisions based on investment motives (e.g., improving future income and employability) and consumption (e.g., better quality of life and local amenities). The analysis used almost the same variables as the Barrioluengo and Flisi study [2], which addressed the 2007–2013 period. As such, it did not include some potentially interesting variables reflecting HEIs or regional features. Some interesting variables that could improve the model's fit and bring new insights were difficult to retrieve.

For example, the ETER database does not store a variable capturing the spectrum of the subjects offered by an HEI other than a very crude seven-subject classification. Table 1 shows all the variables used in the analyses, their definitions, and descriptive statistics.

Table 1. The variables used in the analyses, their definitions, and descriptive statistics.

Variable Name	Definition	Data Source	Mean	Standard Deviation	Number of Valid Cases
	Dependent Variables				
D_Erasmus_rate_all	$\frac{\text{Number of Erasmus incoming students in ISCED 5–8}}{\text{Number of 1000 students in ISCED 5–8}}$	ETER	16.885	25.2537	2066
D_Erasmus_rate_6	$\frac{\text{Number of Erasmus incoming students in ISCED 6}}{\text{Number of 1000 students in ISCED 6}}$	ETER	63.746	813.342	1970
D_Erasmus_rate_7	$\frac{\text{Number of Erasmus incoming students in ISCED 7}}{\text{Number of 1000 students in ISCED 7}}$	ETER	28.441	81.727	1902
	Independent HEI Level Variables				
I1_Teaching_Load	$\frac{\text{Number of students at ISCED 5 and 6}}{\text{Total academic staff (HC)}}$	ETER	10.846	12.316	1816
I2_Fees	$\frac{\text{Total student fees paid to the HEI } \textit{in euros (in PPP)}}{\text{Total number of students}}$	ETER	2,128.6	3542.7	1237.0
I3_Research_intensity	$\frac{\text{Number of ISCED 8 graduates}}{\text{Number of ISCED 5, 6, and 7 graduates}}$	ETER	0.041	0.731	1983
I4_Research_excellence	% of HEI publications in the top 10 % most cited publications	CWTS	0.025	0.054	2066
I5_Research_reputation	$\frac{\text{Number of EU projects and grants}}{\text{Total academic staff (HC) in hundreds}}$	ETER	1.246	13.696	1970
	Control HEI Level Variables				
C1_Size	Total number of 1000 students ISCED 5–8	ETER	7.605	1.107	2041
C2_Decentralisation	Dummy variable, 1 = multi campus HEI, 0 = single campus	ETER	0.277	0.448	2065
C3_Legal	Dummy variable, 1 = public or government supported HEI, 0 = all other legal forms	ETER	0.262	0.440	2054
	Regional Context Variables				
R1_Urban	Population density of the NUTS2 region in which the HEI is established (inhabitants per km^2)	Eurostat demo_r_d3dens	711.931	1608.062	2038
R2_Employment_rate	The employment rate of the NUTS2 population aged 20–34 who have completed tertiary education one to three years before the reference year and who are no longer in education or training	Eurostat edat_lfse_33	83.687	11.686	2025
R3_Regional_earnings	The compensation received by the employees is recorded in the allocation of the primary income account of households divided by the number of employees, in thousand euros	Eurostatnama_10r_2hhinc and nama_10r_2emhrw	20.729	11.396	1910
R4_Educat_Attainments	The proportion of higher education graduates in the population	Eurostatedat_lfse_04	43.389	12.444	2058
R5_Research_excellence	% of the academic publications of the HEIs in the region that are in the top 1% of most cited publications	CWTS	1.688	0.614	1794

Incoming mobility in 2014–2020 shows significant yearly fluctuation (Figure 1). Initially, in 2014, there was a relatively small number of moving students (136,832), which more than doubled (283,376) in 2019. The number of reporting institutions decreased, reaching approximately 1500 by 2019. The significant fluctuation in the number of moving students and participating institutions indicates that it is better to process the data as a cross-section of averages of the 2014–2019 period than a panel with considerable fluctuation and white noise. Thus, all variables recorded are averages of the 2014–2019 values unless otherwise stated. Figure 2 illustrates the average yearly incoming mobility across various educational levels from 2014 to 2019, highlighting that ISCED 6 is the driving force of Erasmus+ incoming mobility, accounting for almost 66.5% or 149,131 of all average yearly incoming students.

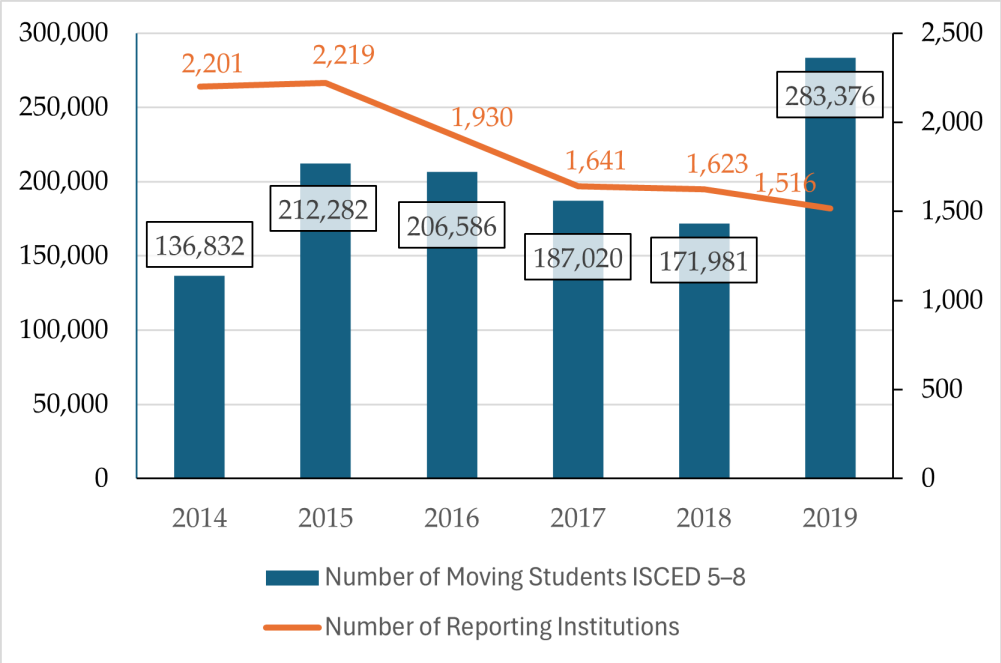

Figure 1. Incoming Erasmus students of all educational levels (ISCED 5–8) and reporting institutions. Source: ETER database at https://eter-project.com/data/data-for-download-and-visualisations/database/ (accessed on 1 March 2024).

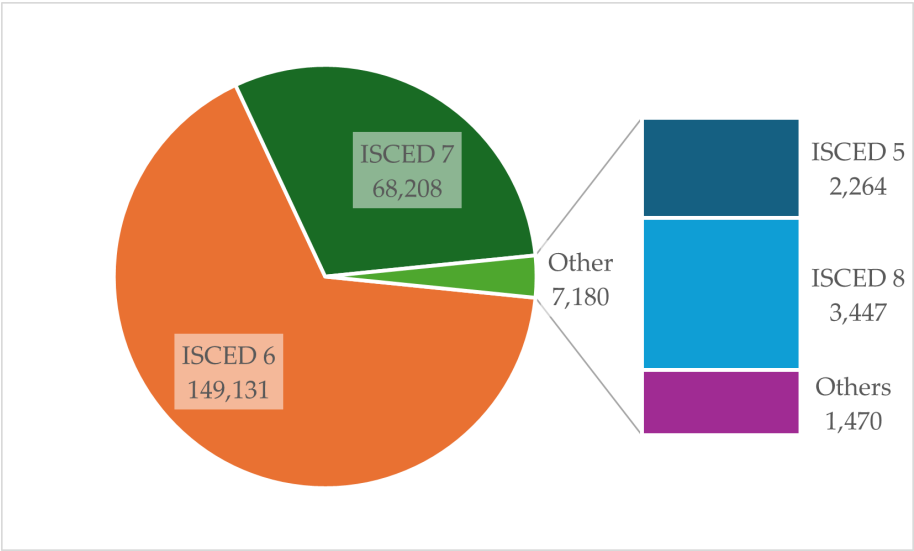

Figure 2. Average yearly incoming mobility at various educational levels, 2014–2019. Source: ETER database at https://eter-project.com/data/data-for-download-and-visualisations/database/ (accessed on 1 March 2024) and own treatment of data.

ISCED 7 follows with 30.4%. The significant shares of ISCED 6 and 7 and the clear differentiation between under and postgraduate studies show that these two levels should be studied separately and in addition to the study of the overall Erasmus student movements. Figure 3 illustrates the yearly incoming students at ISCED Levels 6 and 7 from 2014 to 2019, re-confirms the data fluctuations observed in Figure 1, and highlights that both series fluctuate. Thus, it is better to use the yearly averages of the 2014–2019 period and process the data in a cross-section.

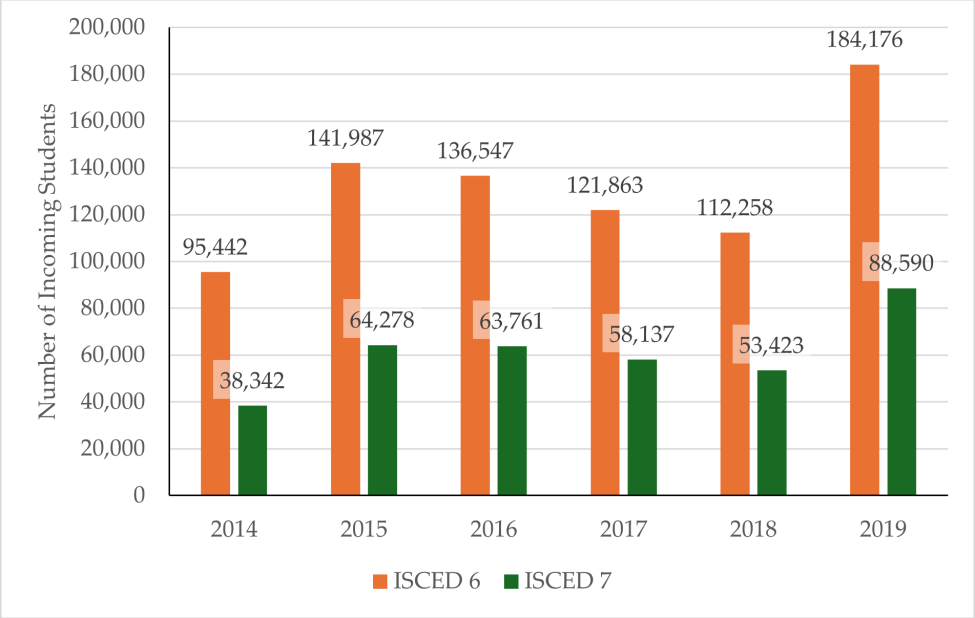

Figure 3. Yearly incoming students at ISCED Levels 6 and 7. Source: ETER database at https://eter-project.com/data/data-for-download-and-visualisations/database/ (accessed on 1 March 2024).

2.3. Methods

2.3.1. Hotspot Analysis

Hotspot analysis is a widely used spatial statistical technique that identifies geographic areas where the observed values of a variable significantly deviate from expected values, either through clusters of unusually high (hotspots) or low (cold spots) values. In this work, hotspot analysis will reveal spatial trends and clusters that might not be visible in non-spatial analyses between the average yearly number of incoming Erasmus students at the HEI level and the ratio of Erasmus incoming students to the total number of registered students. By examining the spatial distribution of a variable across a study area, hotspot analysis reveals areas where patterns are not random but exhibit statistically significant clustering. This method employs tools like the Getis–Ord Gi statistic, which evaluates the degree of spatial clustering by comparing local values to a broader spatial context. For example, the Getis–Ord Gi method shows that when one HEI stands out, it has a high ratio of Erasmus incoming students to total registered students, and the surrounding HEIs do, too. This cluster is a hotspot for high incoming student rate HEIs or highly attractive HEIs which actively internationalise.

On the other hand, a cold spot is an area where HEIs do not have high ratios of Erasmus incoming student rates, and neither do their neighbouring HEIs. Thus, a statistically significant hotspot indicates a localised concentration of high values, while a statistically significant cold spot signifies a spatial concentration of low values. These clusters are assessed based on statistical confidence levels, ensuring the observed patterns are unlikely to be due to random chance. Hotspot analysis identifies areas of interest by highlighting clusters with unusually high or low values of the variable measuring incoming Erasmus students or the rate of Erasmus to total students. These clusters can guide policy and decision-making at the HEI and regional levels by providing evidence-based insights for targeted interventions.

Hotspot comparison compares two different hotspot analyses to examine how they relate. In practice, the comparison examines each location and categorises it based on its significance in both analyses. This results in the similarity index in hotspot comparison, which ranges from −1 to 1 and indicates how similar the spatial patterns are between two

hotspot analyses. Values closer to 1 suggest the phenomena under comparison tend to cluster in the same areas, values closer to −1 indicate they cluster in opposite areas, and values near 0 suggest no meaningful relationship between the spatial patterns. Usually, a similarity index between 0.4 and 0.6 implies medium similarity, 0.6–0.8 substantial similarity, and above 0.8 extreme, near-perfect similarity. This results in a new map showing the similarity of each hotspot of one hotspot analysis to the corresponding location of the other analysis. The maps of the hotspot comparison analysis in this work present only hotspots with similarity above 0.6.

2.3.2. Multilevel Analysis

The Erasmus incoming data refer to each HEI. HEIs are clustered into NUTS 2 groups and operate under the same regional socioeconomic and political environment. Multilevel models can take account of this hierarchical nesting in data, recognise that observations of HEIs within regions are not independent and respect the real-world structure of how data are organised. By understanding the variation at the two different levels, HEI and regional, the model can measure how much variation exists between regions and within regions and identify if the regional level contributes significantly to the overall variation. This work uses the two-level random intercept specification, which is presented below.

For the HEI i in region j, the ratio of Erasmus incoming students to total registered students y_{ij}:

$$y_{ij} = \beta_{0j} + \beta_1 X_{ij} + e_{ij} \quad (1)$$

where β_{0j} is the random intercept for region j, and X_{ij} is the individual level (HEI) predictor, β_1 is a coefficient to be estimated with fixed slopes across regions, and e_{ij} is the individual-level (HEI) residual error following a normal distribution with mean zero and variance σ_e^2 $\left(N\left(0, \sigma_e^2\right)\right)$. The random intercept β_{0j} is modelled as follows:

$$\beta_{0j} = \gamma_{00} + \gamma_{01} W_j + u_{0j} \quad (2)$$

where γ_{00} is the overall intercept, i.e., the grand mean of the Erasmus incoming student rate, W_j is a regional-level predictor, γ_{01} is the coefficient for the regional-level predictor, u_{0j} is the regional-level random effect, following a normal distribution with mean zero and variance σ_u^2 $\left(N\left(0, \sigma_u^2\right)\right)$. By substituting regional-level Equation (2) into HEI-level Equation (1), we have the following:

$$y_{ij} = \gamma_{00} + \gamma_{01} W_j + \beta_1 X_{ij} + u_{0j} + e_{ij} \quad (3)$$

The Intraclass Correlation Coefficient (ICC) measures how similar observations are within the same region by quantifying how much of the total variation in the outcome is due to differences between regions. The ICC is

$$\text{ICC} = \frac{\sigma_u^2}{\sigma_e^2 + \sigma_u^2} \quad (4)$$

or, in other words, the ratio of the variance between regions to the total variance between and within regions. The ICC ranges from 0 to 1 (or 0% to 100%), with a higher ICC meaning HEIs within the same region are more similar and a lower ICC means HEIs within regions are more different from each other. In general, higher ICC values, typically greater than 0.05, are another reason to justify the use of multilevel modelling besides the theoretical reasons and the natural hierarchical clustering of the data [17,18].

2.4. Hypotheses

The three research aims of this work are the three following hypotheses:

Hypothesis 1a (H1a). *Erasmus+ student mobility generates "hot" and "cold" spots of HEIs based on two dimensions: (i) absolute numbers of incoming students ("scale") and (ii) the ratio of incoming Erasmus students to total registered students ("reception capacity").*

Hypothesis 1b (H1b). *Hot and cold spots of HEIs of "scale" coincide with hot and cold spots of "reception capacity".*

Hypothesis 2 (H2). *The regional location of HEIs significantly influences their capacity to attract and host incoming Erasmus students.*

Hypothesis 3 (H3). *Specific socioeconomic and educational characteristics of the NUTS2 regions in which the HEIs are located critically shape the rate of incoming Erasmus students and, consequently, the success of these institutions in internationalisation.*

3. Results

3.1. The Geography of Erasmus Incoming Students

In their analysis, Barrioluengo and Flisi (2017) [2], showed that Spain was the leading destination, attracting more than 16.3% of all Erasmus students in 2013, followed by Germany (12.2%) and France (9.6%). The UK and Italy also ranked high, receiving 9.4% and 9.1%, respectively. The order remains almost the same in the 2014–2019 period, with Spain accepting an average of 36,220 or nearly 16.5% of all Erasmus students, followed by Germany (11.3%), the UK (9.2%), Italy (7.7%), France (7.2%), Poland (7.0%), and Portugal (5.5%). Allocations between ISCED 6 and 7 incoming students also do not differ much from 2013. These distributions are, of course, influenced by the Erasmus+ programme's centralised management of scholarships and their allocation across countries. So, what matters more is whether Erasmus's incoming students create hot or cold spots. A hotspot is not just a single HEI with a high value for the number or the ratio of incoming Erasmus students but a group of HEIs with statistically verified high values different from what one would expect by chance, considering the overall pattern of Erasmus incoming movements. Correspondingly, a cold spot is a group of HEIs defined by a spatial relationship with statistically verified low values.

The top line of Figure 4a shows hot and cold spots for the yearly average number of incoming Erasmus students for all educational levels (left) and ISCED 6 (middle) and 7 (right) separately. The figure shows only hot and cold spots of 99% confidence intervals because the more significant the z-score (positive or negative), the more intense the clustering. Figure 4a reveals four trends. First, although Spain, Germany, the UK, Italy, Poland, France, and Portugal received the most significant number of Erasmus students in 2014–2019, hotspots are only formulated in Spain, France, and Portugal. Second, countries that did not receive many Erasmus students, like Ireland, show the formation of significantly strong hotspots, revealing a spatial targeting for incoming Erasmus students. The south of Sweden is a surprisingly significant hotspot with HEIs in Gothenburg, Jönköping, Linköping, Skövde, and other southern areas, all in a circle with a radius of less than 150 km. Third, cold spots emerge not only in countries that receive low numbers of Erasmus students, such as Bulgaria, Romania, or Croatia but also in Poland, the sixth largest receiver among all EU Member States. Fourth, the patterns for ISCED 6 and 7 are different. North England, Scotland, and Northern Ireland are UK regions with hotspots for ISCED 6, while Sweden emerges as a country with highly populated ISCED 7 hotspots. This may indicate HEI

specialisation in Erasmus ISCED 6 or 7, a sign of strategic internationalisation worth further research. Germany has numerous cold spots for ISCED 6 and Poland for ISCED 7 students.

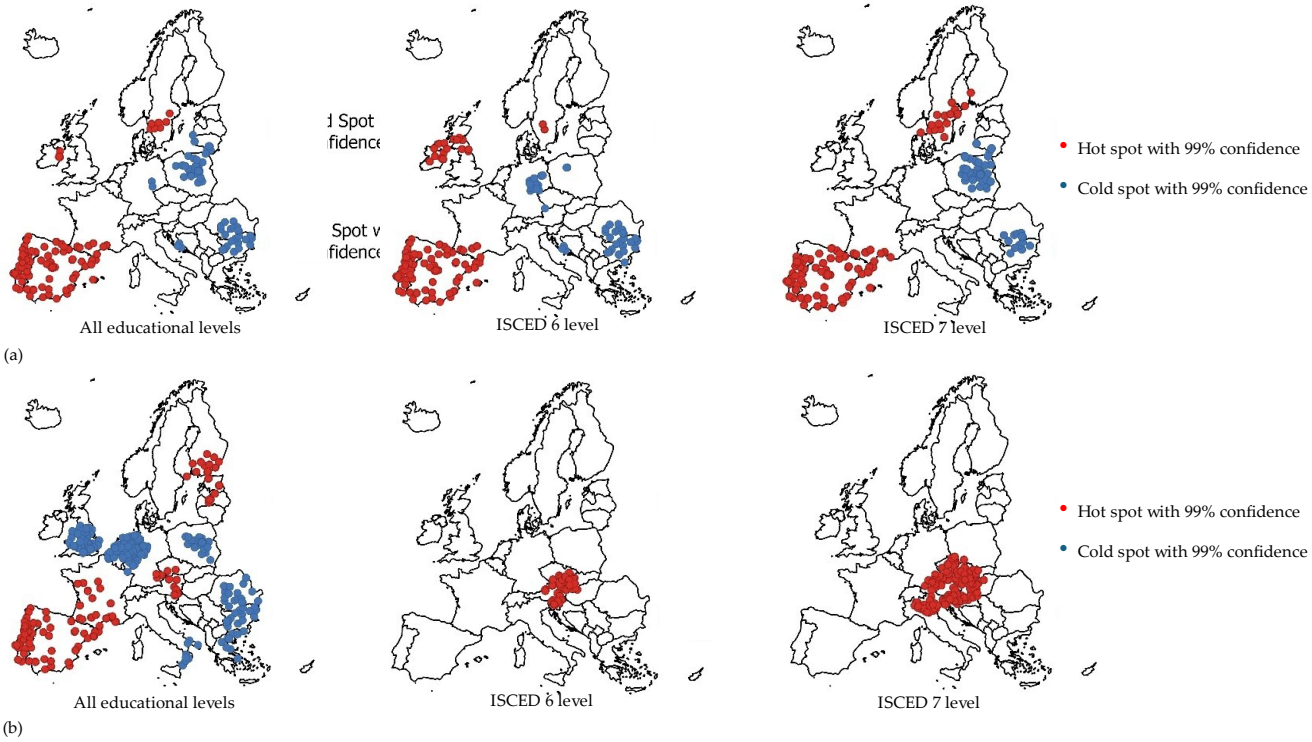

Figure 4. Hot and cold spots of (**a**) the average annual number of incoming students 2014–2019, and (**b**) the average annual rate of incoming students 2014–2019.

The bottom row of Figure 4b shows the hotspot analysis for the average ratio of incoming Erasmus students to total registered students as defined above (Table 1). This ratio reflects the capacity and willingness of HEIs to attract and accommodate incoming Erasmus students based on the size of their student population. In this case, hotspots are statistically significant groups of HEIs, defined by a spatial relationship, with high numbers of incoming Erasmus students per 1000 of their total student population. For ISCED 6 and 7, this ratio is defined by the ISCED 6 or 7 incoming Erasmus students per 1000 of the total number of registered ISCED 6 or 7 students. Hot and cold spots in the ratio of incoming Erasmus students are due to the coexistence of ISCED6 and 7 Erasmus students. HEIs usually receive both ISCED 6 and 7 students; thus, examining hot and cold spots for the total number of Erasmus students is reasonable. The Spanish, Portuguese, and French hotspots dominate, but new hotspots emerge in Finland, the Baltic countries, and central Europe, including the south of Germany, Austria, and the Czech Republic. Concurrently, cold spots appear in the UK, central and south England, the Benelux, northwest Germany, Greece, and the very south of Italy.

The study also examines whether hot (or cold) spots for the number of incoming Erasmus students co-locate with corresponding hot (or cold) spots for the ratio of Erasmus students to registered students, i.e., the HEI's capacity and willingness to internationalise. The possible coexistence of hotspots from these two variables cannot be deduced directly by observing the corresponding maps of the top and bottom rows because these maps show only hot and cold spots with 99% confidence intervals. For all educational levels, the global similarity value is 0.42, indicating a medium similarity. In other words, hot or cold spots of the number of Erasmus students have a medium correspondence to hot or cold spots of the rate of Erasmus students to total students. For ISCED 6, the overall similarity index is 0.36, not even medium, while for ISCED 7, it is 0.46. The hotspot analysis comparison

reveals that hotspots regarding the number of Erasmus students do not usually coexist with hotspots regarding the ratio of Erasmus to registered students. In addition, the differences in hotspots between educational levels again indicate that many HEIs may pursue selective strategies for attracting one or the other educational level but not both.

The preceding hotspot analyses and hotspot analyses comparisons indicate that Hypothesis 1a is partly accepted and partly rejected. Top countries in Erasmus+ student mobility, such as the UK, Germany, Italy, and Poland, failed to show the formation of any hotspots of HEIs. Spain, Portugal, and partly France show substantial and statistically significant clusters of HEIs concerning both the absolute number of incoming Erasmus students and the ratio of incoming students to total registered students. Hypothesis 1b is rejected because the evidence supporting it is very weak. Clusters of HEIs with substantial Erasmus students do not co-locate with clusters of HEIs with a high ratio of Erasmus to total registered students.

3.2. A Model of the HEI and Regional Factors Affecting Student Mobility

Table 2 presents the results of fitting various specifications of the basic two-level random intercept model in Equations (1)–(4). All HEI-specific variables are group-centred, i.e., the regional mean is subtracted from each HEI's score. For example, the first HEI on the ETERO database has an average teaching load in the period 2014–2019 of 7.61 ISCED 5 and 6 students per member of academic personnel. The regional average of the 20 HEIs in this region is 3.80; thus, its group-centred score is 3.81 = 7.61–3.80. This transformation is usual because it helps separate within-group variation from between-group variation in multilevel analyses. Of course, regional variables are not group-centred. The goodness of fit measures include the conditional pseudo R-squared (R_c^2), an extension of traditional R_c^2 to multilevel models, which have both fixed effects and random effects. It reflects the proportion of the total variance in the outcome variable explained by the model's fixed effects predictors and the random effects, which consist of the region-level variation. SPSS v.29 estimates the conditional R_c^2 following the Nakagawa and Schielzeth approach [19]:

$$R_c^2 = \frac{\sigma_f^2 + \sigma_u^2}{\sigma_f^2 + \sigma_e^2 + \sigma_u^2} \quad (5)$$

where σ_f^2 is the variance explained by the fixed effects and σ_e^2 and σ_u^2 are the residual and random variances defined in the ICC of Equation (4). The smaller the part of the variance explained by fixed effects σ_f^2, the closer the R_c^2 is to the ICC.

The simplest multilevel model allows for regional effects on the rate of Erasmus incoming students but without explanatory variables. This "null" model, given Equation (3) above, may be written as follows:

$$y_{ij} = \gamma_{00} + u_{0j} + e_{ij} \quad (6)$$

with the notation as above and the results shown in Table 2 ("Model 1"). The ICC is 0.087, indicating that 8.7% of the variance in the ratio of Erasmus incoming students to registered students can be attributed to regional differences, i.e., location, without the contribution of any other explanatory variable. A likelihood ratio test comparing Model 1 "null model" with a single-level model without explanatory variables can formally test the statistical significance of regional effects since the two models are directly nested, and their only difference is the additional term introduced by the second-level (regional) effect. The likelihood ratio statistics is LR = $-2 *$ (19,203.98–19,110.11) = 187.74 on 1 d.f. Thus, the two-level complex model fits the data significantly better than the single-level model, providing overwhelming evidence of regional effects on the ratio of incoming Erasmus students.

Table 2. Results of the different estimated multilevel models.

	Model 1 (The Null Model)	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Dependent variable	Erasmus_rate_all	Erasmus_rate_all	Erasmus_rate_all	Erasmus_rate_6	Erasmus_rate_7
Fixed effects—HEI specific					
I1_Teaching_Load		−0.308 ***	−0.354 ***	−4.647	−0.209
I2_Fees		0.688 **	---	---	
I3_Research_intensity		0.264	0.015	2.767	0.715 **
I4_Research_excellence		41.436 **	37.126 **	−13.683 *	0.897
I5_Research_reputation		0.817 **	0.625 **	55.691 ***	−1.706
C1_Size		−0.255 **	−0.157 **	−3.901	−0.586 *
C2_Decentralisation		−1.072	−1.091	19.578	5.467
C3_Legal		−3.364	1.054	−39.263	−0.513
Fixed effects—region specific					
R1_Urban		3.797×10^{-5}	0.001	−0.033	−0.003
R2_Employment_rate		0.062	0.045	−4.726	0.022
R3_Regional_earnings		−0.360 **	−0.206	13.803 **	−0.649
R4_Educat_Attainments		0.178 **	0.252 **	9.899 **	0.808 **
R5_Research_excellence		6.184 **	3.345	−104.704	19.075 *
Constant	15.763 ***	2.977	2.176	−32.031	−16.929
Statistics					
−2 Log-likelihood	19,110.109	7588.362	12,357.132	20,091.618	13,659.942
Conditional r − squared (R_c^2)	0.087	0.195	0.162	0.158	0.111
HEIs (level 1 observations)	2066	860	1355	1312	1271
Regions (level 2 observations)	277	123	154	154	154

Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

The average (grand mean) ratio of Erasmus incoming students across regions is estimated to be 15.76 per 1000 students at the receiving HEI. For a region j, this is calculated as $15.763 + u_{0j}$, where u_{0j} is the estimated regional residual. For regional residuals, confidence intervals are obtained to determine whether differences from the overall mean can be considered "real" or due to chance. If a region's j regional residual (u_{0j}) is positive, the region has a mean ratio of Erasmus incoming students to registered students higher than the grand mean. If it is negative, it has a ratio below the grand mean. From the 277 NUTS regions in the analysis, 184 have negative but not statistically different from zero regional residuals u_{0j}, and 93 have positive. Figure 5 shows the regional champions in Erasmus internationalisation, i.e., the regions with the highest positive and statistically significant regional residual. For example, the expected incoming Erasmus students per 1000 students in the 28 participating HEIs of the Budapest area (HU11) is 15.76 + 24.3 = 40.06 with confidence intervals from 32.43 to 47.76. Similar performance is shown by the Portuguese regions of Norte (PT11) and Lisbon (PT17), the French Midi-Pyrénées (FRJ2) and Rhône-Alps (FRK2), and the Austrian regions of Vienna (AT13) and Innsbruck (AT33).

The study of residuals reveals how much of the total variance is due to between-group differences, which is crucial for isolating possible good practice examples for further analysis and consideration. For example, the rise in Hungary in general, and of the Budapest area in particular, as an ISCED 6 and 7 student Erasmus students destination is well documented in the academic literature. The hotspot and multilevel analysis results confirm these trends and highlight the importance of regional factors and the presence of strong statistically significant educational clusters. Thus, Hypothesis 2 is accepted.

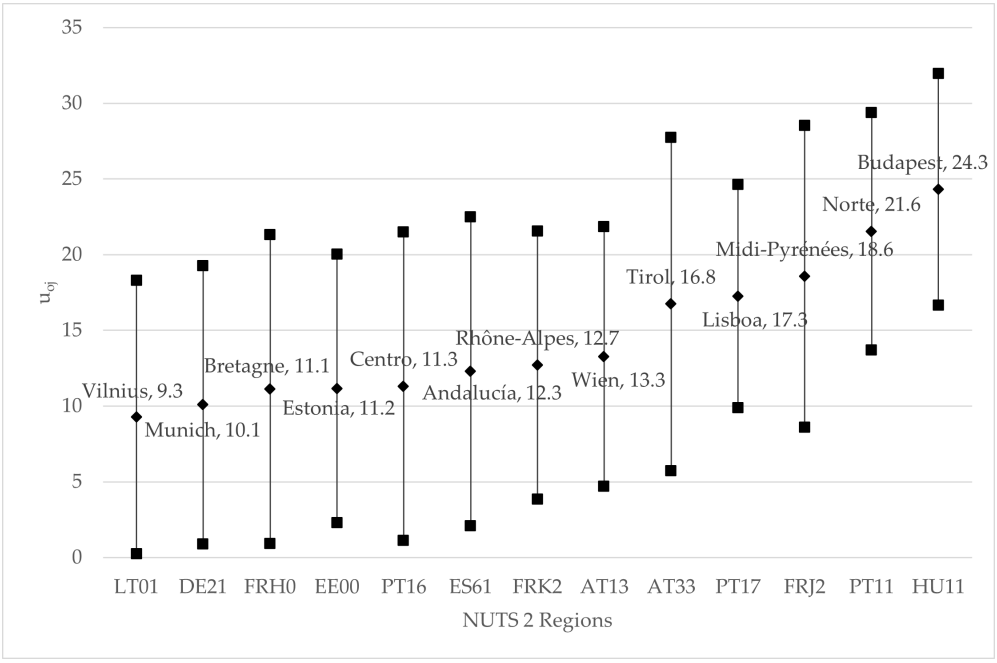

Figure 5. The regional champions of internationalisation: regional residual u_{0j} and confidence intervals on incoming Erasmus students per 1000 students.

The columns titled "Model 2" and "Model 3" of Table 2 show the results of fitting the two-level model with all fixed effects, HEI- and region-specific, for all ISCED levels. Their only difference is that "Model 2" includes the "fees per student" variable, which is also used by [2]. This variable is recorded by only 866 out of the 2066 participating HEIs in 123 out of the 277 regions, which reduces the sample and, thus, the power of the analysis. It is included here to facilitate an immediate comparison with the Barrioluengo and Flisi (2017) [2] study. Model 3 excludes this variable to increase the sample of HEIs to 1355 and attain more robust results. Models 4 and 5 use the same variables as Model 3 but are estimated only for ISCED 6 or ISCED 7 Erasmus incoming students. Before interpreting the results, the reader should consider the possible mobility constraints associated with Erasmus mobility, as discussed in the "Data" section above. Students' second or third choices may justify the rise in destinations next to popular first-choice destinations such as Lisbon, Vienna, or Budapest. The multilevel model assumes that the HEI-specific fixed effects capture and explain the heterogeneity of incoming Erasmus students, including the order of placement preferences. The results reported here should be interpreted with caution, considering these limitations.

With a few exceptions, the fixed effects factors results in Table 2 generally support the analysis performed by Barrioluengo and Flisi [2] and show some very intriguing trends. Universities with lower teaching loads tend to attract or be preferred by more Erasmus students, as a higher teaching load is negatively correlated with Erasmus mobility. Although there is still a negative sign for this variable for the ISCED 6 and ISCED 7 models (4 and 5), the factor is no longer statistically significant. The student fees variable in Model 2 has a statistically significant positive sign, suggesting a positive correlation between the ratio of Erasmus mobility rates and higher student fees. Given that Erasmus participants do not pay fees to the host university, it is possible that higher tuition could serve as a stand-in for perceived institution quality and draw in more students. Both variables confirm the results derived by Barrioluengo and Flisi [2].

The two variables reflecting research activities, i.e., the number of EU grants per staff member and the proportion of HEIs' publications in the top 10 per cent of most cited publications (excellence), both show significant associations with the ratio of Erasmus students,

suggesting that a university's research profile is a highly relevant factor. In many previous studies, university quality was an essential determinant of students' choices [11,20]. Research has shown that the connections are among faculties of institutions rather than the institutions themselves [11]. This finding supports the argument that Erasmus networks are built upon active or pre-existing research partnerships. For postgraduate Erasmus students only, research intensity matters (ISCED 7). Despite using the exact definition of variables and sources as the current study, Barrioluengo and Flisi [2] did not find the research excellence or the intensity variables statistically significant. During the 2014–2019 timeframe, research quality was one of the key determinants influencing the selection of Erasmus agreements and, in turn, Erasmus mobility. For research reputation, the variables between this work and [2] are not comparable since this work did not use the Times Higher Education (THE) university rankings.

The size of an HEI, measured by the yearly average number of students across all ISCED levels, was the only statistically significant condition of the control variables. Its negative sign suggests that the ratio of Erasmus per 1000 registered students decreases with increasing size. For instance, in Model 2, the ratio of Erasmus incoming students per 1000 registered students falls by 0.255 as an HEI grows by 1000 students above the average HEI size in the region. Erasmus mobility is unaffected by the operation of satellite campuses outside the HEI's main campus or by the institution's legal classification as public or private.

Urbanisation, measured as population density, is not statistically significant. The same holds for regional employment opportunities, as reflected in the regional employment rate of recent tertiary graduates. Both results agree with the JRC study [2]. Also, in that study, regions with higher levels of tertiary educational attainment showed a weak but statistically significant and positive association with Erasmus mobility [2]. In the current study, regional educational attainment, measured by the proportion of higher education graduates in the regional population, is consistently statistically significant, positive, and with a considerable effect size.

The concentration of higher education graduates in a region is a factor that may mask various regional aspects and manifests through enhanced innovation and entrepreneurship [21], economic growth [22,23], community engagement, lifelong learning opportunities, increased attractiveness for investments, and contributions to research and development to support a high level of regional competitiveness [24–26]. The higher proportion of individuals with higher education in a region positively impacts the quality of life through economic benefits, social cohesion, improved health outcomes, access to educational resources, and innovation, collectively contributing to a more vibrant and sustainable community. Researchers name the regional factors as "offerings of the city", encompassing factors such as the city's atmosphere, cultural offerings, amenities, and overall environment that contribute to the students' satisfaction and experience during their time abroad [27]. Quality of life and the development and enhancement of amenities are driven by increased investment in infrastructure, business development that spurs local services, enhanced cultural opportunities, improved access to health services, and the presence of educational institutions that contribute positively to community life, creating a more attractive living environment that benefits all residents. Shapiro's seminal work showed that a 10% increase in a metropolitan area's concentration of college-educated residents is associated with a 0.8% increase in subsequent employment growth, with 60% due to enhanced productivity and 40% due to growth in quality of life [28].

In general, evidence favours the acceptance of Hypothesis 3, which states that the specific socioeconomic and educational characteristics of the NUTS2 regions in which HEIs

are located influence the rate of incoming Erasmus students and the internationalisation efforts of these institutions.

4. Discussion and Regional Policy Implications

International mobility of tertiary education students profoundly affects the regions that host them, influencing social, economic, and cultural dynamics. This is why attracting international students through the Erasmus+ programme has become a strategic objective for many universities. However, the impact varies widely based on the region's socioeconomic characteristics and conditions, shaping how these benefits are realised and integrated into broader regional development strategies. Undoubtedly, HEIs with high rankings and prestige are more likely to be chosen by Erasmus+ students seeking quality education abroad, with regional factors being equally important.

There are significant spatial disparities in the distribution of incoming students among HEIs. While Spain, Germany, the UK, Italy, Poland, and France host considerable numbers of Erasmus students, statistically significant hotspots emerge only in Spain, Portugal, and parts of southern France, as well as individual locations in Ireland and Sweden. The rise in unexpected hotspots also highlights the dynamics and the changing character of Erasmus movements after Brexit, COVID-19, and significant geopolitical changes in Europe and internationally. A comparison of hotspots for absolute numbers of students and the ratio of Erasmus students to total registered students shows limited overlap, suggesting that HEIs excelling in one metric do not necessarily perform well in the other. This work does not provide explanations of how such clusters emerged and does not study their spatio-temporal dynamics. However, it points out where in space to look for interesting case studies, hot or cold spots, that will further the knowledge of the factors determining HEI internationalisation.

The high concentration of university graduates, higher earnings, and a regional environment supporting research excellence characterise regions exhibiting higher attractiveness for Erasmus participants. These results suggest that enhancing such factors can make less attractive regions more appealing destinations for Erasmus students. Findings indicate that regional and local authorities can play an essential role by adopting policies favouring the internationalisation of HEIs. Regional and academic authorities should examine and understand the impact of Erasmus mobility flows on specific localities, economies and societies. Based on this, regional and educational authorities should adopt goals concerning the desired quantitative and qualitative characteristics of the students to be attracted, such as the number of students concerning local capacity, the targeted educational levels and disciplines, and others.

Researchers suggest reorientating the Erasmus programme based on reevaluating the programme along the broader cohesion policy, focusing on "left-behind" places and recommending that solutions be designed carefully and implemented with attention to local contexts [1]. Findings from the current work and especially evidence from hotspot analyses support this perspective. However, it may be necessary to improve the condition of local governments to ensure that they can effectively utilise the resources available to them and take advantage of a possible re-alignment of the Erasmus programme with cohesion targets. The latter may include introducing almost subtle conditionalities and gentle policy interventions to improve the current allocation of Erasmus flows, aiming to create a more balanced distribution among regions. At the same time, HEIs should be utilised as tools for regional policy, engaging more actively in local development and supporting the local innovation system, serving the need for HEIs to strengthen their connection to regional needs.

5. Conclusions

The paper highlights the significant role of the Erasmus+ programme in shaping the internationalisation of (HEIs) across Europe, particularly emphasising the spatial disparities in student mobility. It reveals that while countries like Spain, Germany, and the UK receive the largest numbers of Erasmus students, statistically significant hotspots of incoming mobility are predominantly found in Spain, Portugal, and parts of southern France, with unexpected hotspots emerging in countries like Ireland and Sweden. The analysis indicates limited overlap between the absolute numbers of incoming students and the ratio of Erasmus students to total registered students. This suggests that HEIs excelling in one metric may not necessarily perform well in the other. This complexity points to further investigation into the spatio-temporal dynamics of these mobility patterns, particularly in recent geopolitical changes such as Brexit, the COVID-19 pandemic and the emergence of new student destinations globally.

Furthermore, the findings underscore the importance of regional socioeconomic characteristics in attracting Erasmus students. Regions with a high concentration of university graduates, better employment opportunities, and intense research environments are more appealing to Erasmus participants. The study concludes that to enhance the attractiveness of less popular regions, local and regional authorities should adopt targeted policies that improve regional conditions, such as investing in higher education and fostering local innovation systems. Moreover, evidence suggests that regional authorities should challenge the current spatial allocation of Erasmus flows to better align with broader cohesion policies, mainly focusing on "left-behind" areas, thereby ensuring a more balanced distribution of benefits from HEIs' internationalisation.

By striving for greater equity through Erasmus+ mobility, the EU can ensure that the programme's economic, social, and cultural benefits are more evenly shared, supporting the vision of a more cohesive, innovative, and inclusive Europe. Such a scenario would reduce regional inequalities in access to international education, foster mutual understanding and integration across diverse regions, and contribute to sustainable regional growth and resilience in the face of geopolitical and economic challenges. This would highlight the need to move from a system where Erasmus+ reinforces existing regional imbalances to actively supporting more significant equity, regional development, and cohesion across the EU. The above aligns with the empirical findings and the study's policy recommendations. It would require a mix of targeted policy interventions, investments in regional capacity, and a reorientation of Erasmus+ funding mechanisms.

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