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RESEARCH ARTICLE

REVISED Investing in human capital in the era of European Universities: The uneven geography of skill mismatches across the regions of the European Reform University Alliance

[version 2; peer review: 2 approved, 1 approved with reservations]

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Abstract

This paper examines the uneven geography of skill mismatches by studying the regional allocation of highly educated workers in high, medium or low skill-level occupations. To this end, a conceptual framework is developed combining Geographical Political Economy with theorizations around the optimal allocation of human capital. A comparative empirical analysis is then conducted using the Location Quotient Index for the period 2009-2021 for five countries (Greece, Bulgaria, France, Germany and Denmark), where the universities affiliated to the European Reform University Alliance (ERUA) are located. The results of this analysis are then contextualized through correlations with various macroeconomic, population density, and demographic metrics, which represent factors underlying the uneven geography of skill mismatches. The analysis stresses five critical factors behind the regional and occupational allocation of skills: economic dynamism at the national level, regional industrial specializations, urbanisation levels, demographic structures, and institutional endowments. Moreover, it is argued, these factors behind human capital development tend to reproduce geographical unevenness rather than ameliorating spatial inequalities. Based on these observations, a set of policy actions is recommended based on the five factors mentioned above and the EU's New Skills Agenda. With the above, the paper offers valuable insight into the negative externalities associated with skills mismatches, taking into account the different socio-economic models and school-to-work transition systems across the EU. Moreover, it attempts to make a positive contribution to the European Universities Initiative, as examining the skills gaps in the regions associated with the ERUA strengthens the

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Alliance itself and helps to bridge existing inequalities.

Plain language summary
The economic downturn of the last fifteen years, beginning with the 2008/09 Global Crisis up to the currently unfolding energy crisis, have shaped and accelerated the European Commission's efforts towards the digital and energy transitions (often referred to as twin transitions), paying particular emphasis on workforce's skills and education. The EU Skills Agenda sets ambitious targets to ensure access to education and lifelong learning in all regions of the Union. Adopting a comprehensive approach which incorporates institutional, evolutionary, and political economic influences, this paper examines the uneven geography of skill mismatches by studying the regional allocation of highly educated workers and whether they tend to be employed in high, medium or low-skilled occupations.

To do so, a comparative empirical analysis is conducted using the Location Quotient Index for the period 2009-2021 for five countries (Greece, Bulgaria, France, Germany and Denmark) where the universities affiliated to the European Reform University Alliance (ERUA) are located. Specifically, the consortium implemented the ReERUA Horizon Project (Grant agreement ID: 101035808), in the frame of which the analysis at hand is conducted. The results of this analysis are then correlated with various metrics that pertain to factors that influence the spatial allocation of workforce skills.

The paper reveals five factors that are critical to the geographical and functional allocation of skills: economic dynamism at the national level, regional industrial specializations, urbanisation levels, demographic structures, and institutional endowments. Finally, a set of policy actions are recommended based on the five factors mentioned above and the EU's New Skills Agenda.

Keywords
Human Capital Theory critique, Geographical Political Economy, comparative analysis, highly educated employees

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REVISED **Amendments from Version 1**

We would like to thank the reviewers for their valuable and insightful comments. We have proceeded with major revisions on our manuscript, following most of their points, which we found well raised. Summarily, the main changes made to the manuscript are as follows:

The targeting of the manuscript was reoriented more clearly towards the inquiry of the uneven geography of skill mismatches. This is reflected in all Sections.

In line with the first point above, the Theoretical and Conceptual Section has been extensively revised to reflect this reorientation.

The Empirical Analysis has also been extensively revised, that includes a part where the geographical allocation of highly educated workers in high, medium, and low skill-level occupations is correlated with a series of metrics related to the factors discussed in detail in the next (Discussion) Section. To this end, a Correlation matrix of several factors that influence the spatial allocation of workforce skills was added. The table showing the Share of highly educated workers in low, medium and high skill-level occupations, per region, 2009 and 2021 was moved to the Annex at the end of the paper, for clarity reasons.

In line with the previous point, the Discussion has been revised so that the postulations disclosed, appear more evidence-based.

Lastly, the policy recommendations in the Conclusions Section have been further specified considering our conclusions on the uneven geography of skill mismatches.

Any further responses from the reviewers can be found at the end of the article

Introduction

During the past five decades, long processes of de/re-industrialization brought the importance of workforce's skills to the forefront (Thrift, 2008). In the current unstable conjuncture, which has been marked by successive crises, including the 2008/09 Global Crisis, the COVID-19 pandemic, and the subsequent energy crisis, governments and regulatory bodies keep stressing the importance of new hard skills—often associated with the digital and green transitions—as well as soft skills related to problem-solving and adaptability to changing conditions (McGuinness *et al.*, 2018). Indicatively, the European Commission (EC) has published relevant *agendas* (EC, 2016; EC, 2020), while it proclaimed 2023 as the "European Year of Skills." EC's targets for up-/re-skilling initiatives and its policy toolkits strongly resonate with the basic tenets of Human Capital Theory (HCT from now on; Becker, 1964; Mincer, 1958). In this context, investment in education and VET (Vocational Education and Training) is presented not only as a way for employees to improve their skills and competencies but also as a means for upgrading human capital overall, which can lead to economic growth (EC, 2016; EC, 2020).

Despite the above, there are still significant skill mismatches in many European regions, which the EU is trying to alleviate by better linking education and employment, supporting training programmes, and promoting labour mobility. Notably, a key factor in the Europe 2020 Strategy for achieving dynamic labour markets and efficient job matching is labour mobility (European Commission, 2012); to this end, the EU has launched the EURES (EURopean Employment Services) platform and EPALE (Electronic Platform for Adult Learning in Europe). Yet, such efforts have brought varying results, given regional differences overall, including in educational structures. Such differences can reproduce unequal social relations (Galiakberova, 2019), and ultimately, have led to a highly uneven geography of mismatches. In addition, from the perspective of Geographical Political Economy, beyond differences in regulatory, educational, or industrial structures, the very decisions of local, non-business actors regarding education are not always rational and are crucially influenced by the trajectories of globalization, reproducing spatial inequalities all over again (Teixeira, 2022). Notably, most dominant theories related to skills and education are not clearly evidence-based (Tan, 2014; Teixeira, 2022), while empirical research on skill supply and demand has produced several contradictory findings (Brunello & Wruuck, 2021; McGuinness *et al.*, 2018; Sala, 2011).

In an effort to offer a fresh eye on the literature's contradictory results and rectify its gaps, the paper at hand examines the regional allocation of highly educated workers and examines where they tend to be employed in high-, medium-, and low-skill occupations. This research subject is particularly crucial, considering that overskilling indicates severe short- and long-term consequences. To do so, the paper develops a conceptual framework that combines Geographical Political Economy and human capital-related theorizations. Then, it conducts a comparative empirical analysis that utilises the Location Quotient Index (LQ from now on) for the period 2009–2021 and on 5 countries (Greece, Bulgaria, France, Germany, and Denmark), with the results of this analysis being subsequently correlated with several macroeconomic, population, and demographic metrics that pertain to factors that influence the spatial allocation of workforce skills. Given that the study at hand is conducted for the European Reform University Alliance (ERUA), it is geographically focused on the countries where the Alliance's universities are based. Specifically, the Alliance comprises universities based on North and South Aegean in Greece, Ile de France, Yugozapaden in Bulgaria, Freiburg in Germany, and Sjlland in Denmark; throughout the analysis, particular emphasis is put upon these regions.

Our study concludes that five factors are decisive for workforce skills' geographical and functional allocation: economic dynamism at the national level, regional industrial composition, level of urbanization, demographics, and institutional characteristics. Moreover, it underlines that the mechanisms of human capital development tend to reproduce uneven development rather than ameliorating spatial inequalities.

The above outlines our paper's multifarious contribution. On the one hand, it offers valuable insight into the negative externalities associated with skill mismatches, taking into account Europe's different socio-economic models and school-to-work

regimes (Pohl & Walther, 2007), as these have been identified in the literature (i.e., Nordic, Continental European, Mediterranean and post-socialist; Farkas, 2011). At the same time, studying skill gaps in ERUA's associated regions strengthens the Alliance itself and helps bridging existing inequalities; more broadly, this is a crucial contribution to the EU's European Universities initiative.

The paper is structured as follows. The next section provides a theoretical framework on education and skills in the labour market and develops a conceptual framework based on approaches from Geographical Political Economy and elements from HCT, the concept of optimal allocation, the Job Competition Model, and the Assignment Models. Then it lays out the methodology and presents the results of the empirical analysis. Finally, the key findings are discussed within the context of the relevant literature, while the paper closes with brief conclusions that include a set of policy recommendations.

Human Capital and its uneven spatial distribution: theoretical considerations and a tentative conceptual framework

In general, the skills, competencies, and knowledge required by the workforce are determined by the tasks each worker must undertake for their position and the industry in which they work (Giouli *et al.*, 2021). There are two broad categories of skills. Hard skills are those required to perform a certain job, including for instance language proficiency, expertise on certain software, technical skills, etc. (McGuinness *et al.*, 2018). As these skills are acquired mostly through formal education, (re)training, and on-the-job experience, they are measurable through academic degrees and various types of certificates. Given the latter, this is the type of skills this paper will mostly focus on. Nevertheless, soft skills—also known as non-cognitive skills or interpersonal and personal skills—complement hard skills and are basic competencies needed in the workplace, even if they are not tied to a specific job. Under this category, communication, teamwork, and organizational skills are included, being actively sought after by employers regardless of the sector or occupation (McGuinness *et al.*, *ibid*). Overall, the development of both hard and soft skills is closely linked to better career prospects, either in waged positions or in self-employment (Vinayan *et al.*, 2020).

To engage with the necessary skills required in the workplace, the relevant literature has developed numerous theories. Although having appeared early after WWII, HCT still has a firm grasp on the public discourse and policy documents. Postulating that wage income is a function of education and work experience, HCT highlights the importance of individual educational attainment (Mincer, 1958). Specifically, education increases skills and thus productivity, which is then rewarded with a higher income (Becker, 1964). In fact, the level of education of a workforce remains crucial also on a broader note, as it increases national income and ultimately generates multiplier effects (Pritchett, 2001). Therefore, education is not only crucial for the workers themselves, but also for economies (Tan, 2014). To maximize the effects of higher educational attainment, however, talent has to be allocated in an optimal way, namely, a worker must employ their skills in the most appropriate setting. It is then through the optimal allocation of talent that a higher educational attainment level generates individual and social returns (Acemoglu, 1995).

Despite the undeniable importance of education for developing the necessary skills, skill mismatches are common, pointing to labour markets being rather imperfect in their nature (Teixeira, 2022). Two broad types of mismatches appear in literature. On the one hand, horizontal mismatches refer to cases where workers are engaged in activities outside their field of education and skills. Extensive horizontal mismatches constitute a distortion in the ideal geographical and functional allocation of human capital, reducing the productivity of firms and economic systems in general, and more importantly, profoundly diminishing an economy's capacity to adapt to gradual restructuring processes or sudden shocks (Brunello & Wruuck, 2021). On the other hand, vertical mismatches refer to cases where workers engage in activities that do not match their skill level, namely they are either over- or underqualified for the tasks they perform. Although both instances bear significant consequences for the individual, the firm, and the economy, the paper at hand focuses on overskilling. Otherwise coined as *surplus human capital* (Zhu & Chen, 2016), it has a negative impact on an individual's wages and job satisfaction (McGuinness & Wooden, 2009). Specifically, overskilled workers tend to earn less than those who are in a position matching their skills, tend to have lower satisfaction levels, and are overall more inclined to quit their job. Importantly, they are less keen on acquiring new competences, despite their high education not protecting them from skill obsolescence (Somers *et al.*, 2019). As such, overskilling diminishes employment prospects in the long run, as it undermines incentives for young people to continue investing in human capital (Cedefop, 2015). Many studies have shown that vulnerable groups such as migrants, women and young people are more often trapped in such situations (Cedefop, 2014). For firms, overskilling indicates an untapped potential that is underutilized or not used at all, lowers productivity as their staff is dissatisfied, and limits their adaptation strategies as overskilled workers are reluctant to retrain (Brunello & Wruuck, 2021). On a wider note, for national economies, firms' lower productivity erodes competitiveness and investments in education are not returned into the economy (McGuinness *et al.*, 2018).

Various factors shape the widely documented uneven geography of skills and their mismatches (Alamá-Sabater *et al.*, 2024; Cedefop, 2010). Importantly, regional mismatches can be greatly affected by the robustness (or lack thereof) of the broader national economy. In underdeveloped countries, for instance, talent is more starkly concentrated in spatial and sectoral terms, leading to greater cross-sectoral asymmetries in productivity (Porzio, 2017). In contrast, in developed countries, which are characterized by more dynamic economies, talent is more optimally allocated; however, for this to occur institutional barriers have to be low (Allen *et al.*, 2013). At the regional level, the dynamism of an economy is equally crucial. Capital- and technology-intensive activities tend to concentrate in already advanced regions, fueling new rounds of

uneven development (Viñuela-Jiménez *et al.*, 2010). As such, metropolitan areas with a diverse economic base concentrate human capital, cutting-edge technology, and finance-related activities, while economically backward and declining regions become even more disconnected from knowledge and innovation (Feldman *et al.*, 2021). Similarly, developed industrial regions tend to attract new activities, workforce, and capital, as they further industrialise (Boudeville, 1968), although in many cases they also spill over positive effects to their surrounding areas (Perroux, 1955). However, in most cases, while the latter regions enter virtuous cycles of regional growth, others—mainly peripheral, rural and less developed regions (MacKinnon *et al.*, 2022)—are locked in vicious cycles due to outdated technology, institutional weaknesses and other factors (Rodríguez-Pose *et al.*, 2023). In the above, apart from the dynamism of a regional industrial structure, the sectoral specialization per se plays a key role. Characteristically, sectors like accommodation and catering, commerce and storage, and transportation, are reported to suffer greater skill mismatches—both horizontal and vertical—than others (Chłoń-Domińczak & Żurawski, 2017).

Having said the above, even within regions where significant volumes of high-skilled workers are employed, labour markets have become increasingly polarized, as different fractions of capital seek for both cheap and skilled workers (Capsada-Munsech & Valiente, 2020; Teixeira, 2022). Such segmentation is crucially sustained by dual human capital development mechanisms. Namely, next to a robust education system, a training system that focuses more on vocational training and apprenticeship initiatives is formed, serving as a channel for precarious labour (Teixeira, 2019). Nevertheless, dual educational systems such as Germany's have also been praised for their positive effects in school-to-work transitions, albeit having been oversimplified in the relevant literature (Deissinger, 2015). Similarly praised is the universalistic regime in Nordic countries like Denmark, which invest in human capital and match high levels of educational attainment with demand for such workers (Hadjivassiliou *et al.*, 2019). Beyond educational systems, a number of policy and governance factors can shape youth transition regimes. Indicatively, the role of institutions and stakeholders in counselling and supporting graduates ameliorates or exacerbates spatial disparities in skill mismatches (Ali, 2014); in statist regimes, for instance, employers are not sufficiently involved in matching skills' demand and supply (Capsada-Munsech & Valiente, 2020). As such, in the sub-protective regime of the Mediterranean EU, in countries like Greece, youth transitions to adulthood are long and problematic (Emmanouil *et al.,* 2023). This leads to a large pool of highly qualified people who either cannot find a job, have a profession for which they are overqualified, or have a profession in a different sector from the one in which they were trained, while at the same time many companies are struggling to fill their vacancies (Biagi *et al.*, 2020). Similar phenomena of weak linkages between education and labor market, high levels of temporary employment, extensive skill mismatches and low labor demand characterize the post-socialist regime in countries like Bulgaria (Hadjivassiliou *et al.*, 2019).

Beyond the national and regional factors, sudden shocks of economic or other nature, as well as structural transitions, directly contribute to increasing skill mismatches (Cedefop, 2015). Indeed, the 2008/2009 Global Crisis led to a concerted slashing of public spending on education, impacting on human capital profoundly in the following years (Gourzis & Gialis, 2019). Beyond cuts in public expenses, recession has been found to severely diminish the capacity of policies that are already in place to bring significant effect, especially in the regions lagging behind (Capsada-Munsech & Valiente, 2020; Rodríguez-Pose *et al.*, 2023). On another note, digitalization is predicted to lead to a significant increase in highly skilled occupations, particularly in healthcare and digital technology (Lund *et al.*, 2021), while the number of low and medium-skilled occupations (including many administrative, clerical and manual jobs) is expected to decline, leading to an increasing polarization of the labour market (Chiacchio *et al.*, 2018). Similarly, the green transition will deeply affect jobs in the fossil fuel sectors, affecting certain labour markets disproportionately (Bednorz & Sadauskaitė, 2022). This stresses that the study of the uneven geography of skills and their mismatches is crucially relevant than ever given the new and challenging conditions facing the labour force. Indeed, the Great Recession that began in 2008, the Covid pandemic and the challenges of the twin transitions (the nexus of digitalization and green transformation) have already had and will continue to have a significant impact on labour markets and workplace rules, as they lead to structural changes that affect countries and regions unevenly.

Lastly, it must be mentioned that all the above factors are often shaped through diachronic processes and path dependencies, which can be region-specific or not. For instance, a region's industrial heritage may have shaped a workforce of high level skills, granting it the capacity to adapt to new demands for higher value added industrial activities. In contrast, regions that are less advanced, having diachronically hosted less innovative, technologically backward sectors may not have this capacity (Calcagnini *et al.*, 2021).

Overall, approaching the equilibrium between the supply and demand of skills within an "institutional vacuum" context—namely, detached from processes outside the market and without considering the broader power relations in place (Psilos & Gereffi, 2011)—is unrealistic. This means that skills and labour are constantly influenced by broader processes including demographic and socio-economic changes, institutional settings, and the field of reproduction, which includes family and peer pressure, cultural practices, etc. (Peck & Smucker, 1998). The above attempt to outline how the development of skills is an inherently social process, brought about and maintained by hierarchical power relations within and outside labour markets (Galiakberova, 2019). The influence of powerful non-entrepreneurial actors is key in shaping human capital, as fittingly described by theorizations around Local Labour Regimes (Werner, 2019). Similarly, labour force development is not an equal opportunity field, but rather depends on characteristics such as class, race, gender, ethnicity and migrant

status. In fact, labour force development plays a key role in perpetuating—not only social inequalities but also—labour market segmentation (Teixeira, 2022). The above imply that many reproducing mechanisms of the geography of skill mismatches fuel spatial inequalities by favouring economic stability and growth for certain regions at the expense of others (Teixeira, 2022).

Methodological remarks

The aim of this paper is to study and contextualize the uneven geography of skill mismatches, focusing on highly educated workers. To do so, it first calculates the concentrations of workers with high levels of education in low, medium, and high skill-level occupations. The focus on the workers with high education levels serves in examining the contested issue of overskilling (Brunello & Wruuck, 2021). The severe short- and long-term consequences of overskilling, as indicated in the literature, underline the high scientific importance and policy relevance of this objective. Then, to contextualize the observed uneven geography of skill mismatches, the paper employs a simple correlation analysis, considering various economic, demographic, and spatial metrics that represent crucial underlying factors.

The analysis is conducted at the regional level (NUTS-2) and its geographical scope covers five countries: Greece, Bulgaria, France, Germany, and Denmark. These were chosen on the basis that they represent the main educational/employment regimes in Europe: the universalistic of the Nordic countries, the employment-centered of Continental Europe, the sub-protective of the Mediterranean countries, and the post-socialist of Eastern Europe (Farkas, 2011; Pohl & Walther 2007). While both France and Germany fall under the Continental model, they are both analyzed due to their stark differences in terms of their wage structures (Hein & Vogel, 2009) and educational models (O'Reilly *et al.*, 2019). Given the research's geographical scope covering all main European regimes pertaining to employment and skills, its findings can be contextualized more broadly and provide insight into the EU as a whole. At various points, we focus on the six regions that are specifically related to the ReERUA Horizon Project, in the frame of which the analysis at hand is conducted. These are the North and South Aegean regions in Greece, Île-de-France in France, Yugozapaden in Bulgaria, Freiburg in Germany, and Sjlland in Denmark (see Figure 1). These regions place particular emphasis on the knowledge that comes from their educational institutions; at the same time, they are developing strong knowledge networks within the ReERUA consortium, despite having very different socio-economic structures. As such, they constitute interesting case studies, especially when seen within their broader context.

The analysis is conducted for two years (2009 and 2021), which essentially allows for a comparison between the onset of the

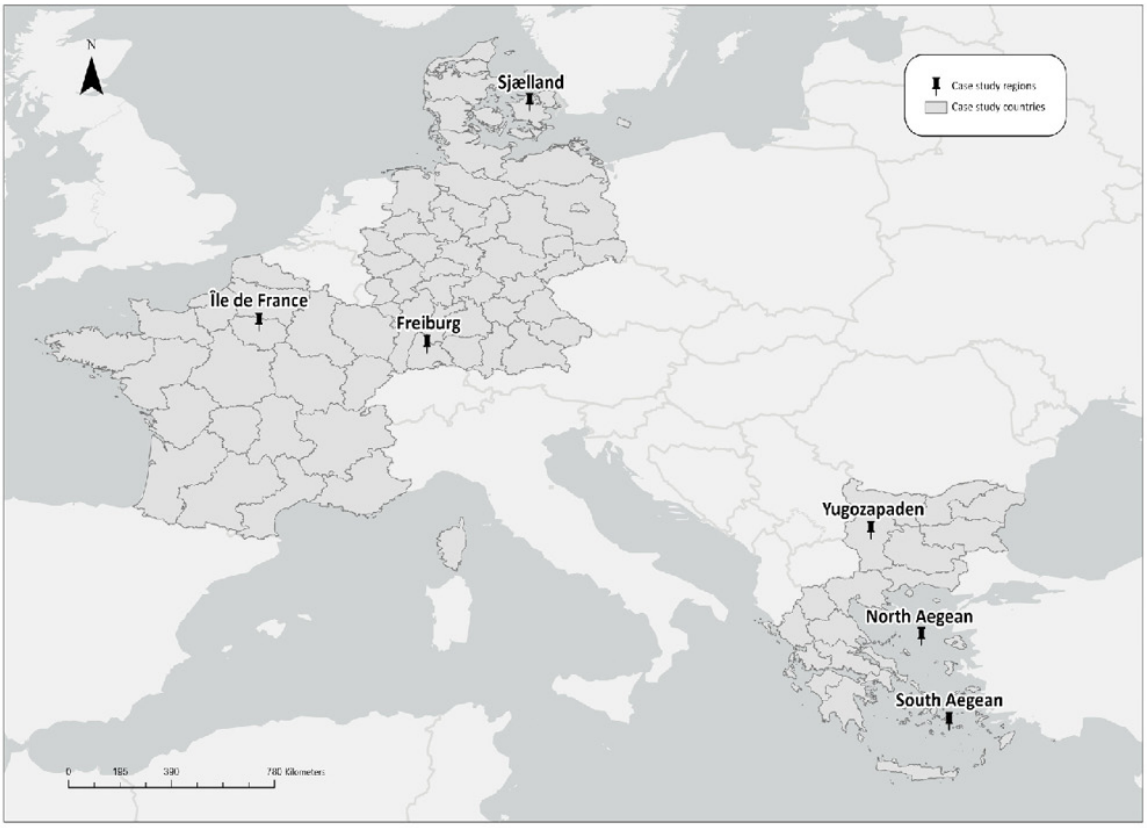

Figure 1. Regions related to the ReERUA Horizon Project. *Source: Own elaboration.*

2008/2009 Global crisis and the most recent available data at the time of the analysis's writing. This temporal scope covers a long period characterized by successive challenges for regional and national economies across the EU, including the Great Recession, which lasted from 2009 until 2013–14 for most European economies, a period of partial recovery between 2015 and 2019, and the two pandemic years (2020 and 2021; Herod *et al.*, 2021). As such, this study elucidates the extent of regions' resilience amidst recessive pressures of various forms.

Data on the matching between highly educated workers and low, medium, and high skill-level occupations are directly calculated by Eurostat,[1] based on its Labour Force Survey. It must be mentioned here that data on highly educated workers in low-skill occupations display many missing values (as evident in Figure 2a and Figure 2b); therefore, results of that part of the analysis must be approached with caution. Eurostat's sample covers all employed persons of both genders, aged 15 and above. Data imputation methods were not used, given that the extent of missing data is limited and most missing values refer to a specific type of skill mismatch (highly educated workers in low skill-level occupations), making most such methods unreliable.

To identify regional concentrations of education/skills per level we calculate the Location Quotient Index (LQ). In general, the LQ highlights the relative concentration of a group within a region compared to its wider context; e.g., the share of industrial workers within a region divided by the respective share at the national level. Here, the LQ index is calculated by dividing the regional shares by the aggregate transnational share of the five countries under study; this serves in directly comparing skill mismatches between European regions. The LQ in the frame of this study shows the relative-to-transnational

[1] From which they were retrieved upon the authors' request in July 2022

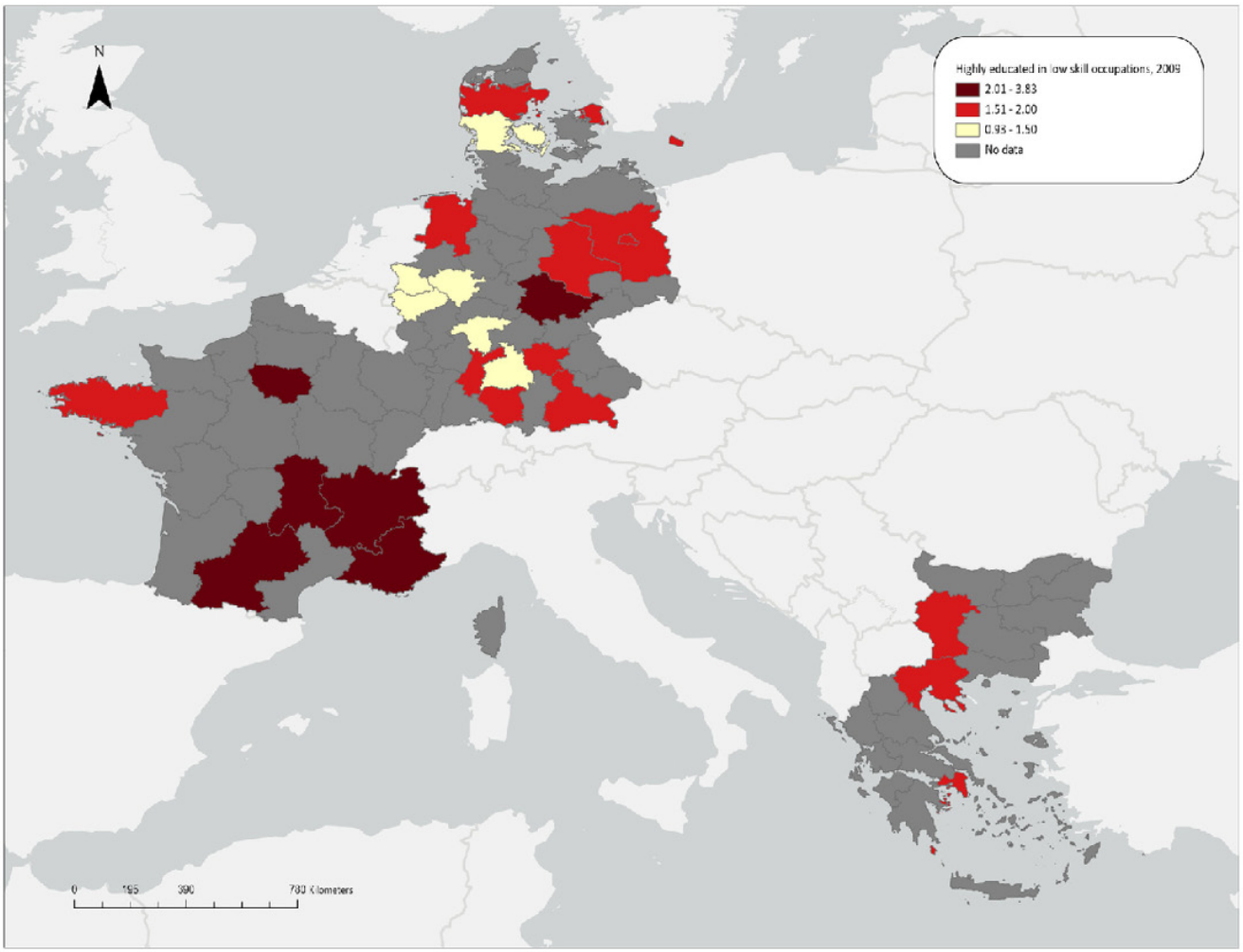

Figure 2a. Over/under-concentrations of highly educated workers in low skill-level occupations, relative regional concentrations 2009. *Source: Own elaboration based on Eurostat data.*

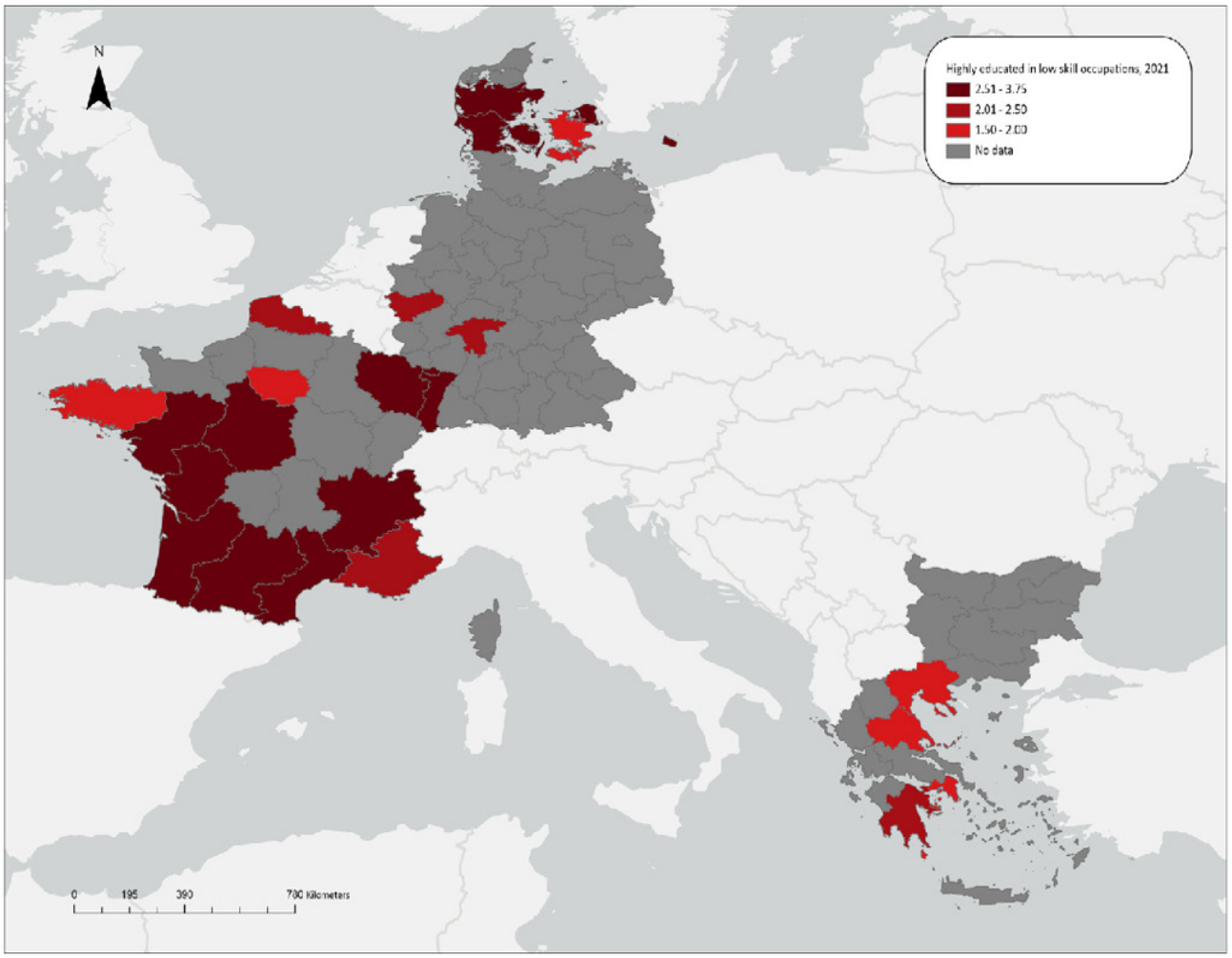

Figure 2b. Over/under concentration of highly educated employed persons in low skill occupations, relative regional concentrations, 2021. *Source: Own elaboration based on Eurostat data.*

concentration of highly-educated employed persons in occupations requiring low [LQ_L)], medium [LQ_M)] and high [LQ_H)] skill levels, calculated through the following formulas (1.1, 1.2 and 1.3 respectively). This way, we find where each type of skill (mis)match is mostly concentrated. In our analysis, values between 0.85 and 1.15 are treated as being close to the average share, values above 1.15 indicate an over-concentration, while values below 0.85 show under-concentration.

$$LQ_L = \frac{ELR/ER}{ELN/EN} \tag{1.1}$$

where E_{LR} is the number of employed persons with high educational attainment in low skill-level occupations in region R, E_R is the total employed population in region R, E_{LN} is the number of employed persons with high educational attainment in low-skill level occupations in all study countries (N), and E_N is the employed population in all study countries (N).

$$LQ_M = \frac{EMR/ER}{EMN/EN} \tag{1.2}$$

where E_{MR} is the number of employed persons with high educational attainment in medium skill-level occupations in region R, E_R is—as above—the total employed population in region R, E_{MN} is the number of employed persons with high educational attainment in medium skill-level occupations in all countries under study (N), and E_N is as above the employed population in all countries under study (N).

$$LQ_H = \frac{EHR/ER}{EHN/EN} \tag{1.3}$$

where E_{HR} is the number of employed persons with high educational attainment in high skill-level occupations in region R, E_R is—as above—the total employed population in region R, E_{HN} is the number of employed persons with high educational attainment in high skill-level occupations in all countries under study (N), and E_N is, as above, the employed population in all countries under study (N).

Apart from calculating the relative regional concentrations using the above formulas (as shown in Figure 2–Figure 4), the paper at hand provides the respective shares of highly educated workers, as allocated in low, medium, and high skill-level occupations (as shown in Annex 1). Doing so, the paper shows the extent of skill mismatches within each region under study.

To distinguish occupations by skill level, Eurostat follows the International Standard Classification of Occupations (ISCO-08) of the International Labour Organization (ILO, 2025). Specifically, occupations are classified as of high skill-level if they correspond to ISCO occupational groups 1 to 3 (managerial and scientific positions), of medium skill-level when they correspond to ISCO levels 4 and 8 (intermediate level manual and non-manual positions), and of low skill-level if they correspond to ISCO level 9 (entry level manual and non-manual positions; see Annex 1). The classification of skill levels was carried out at our request by Eurostat itself, to eliminate the risk of misjudging skill levels and to increase the reliability of the mismatch index. Also, as the focus of this paper is on the regional level, our analysis cannot include skill mismatches by sector and region, given that this would lead to extensive data fragmentation and therefore to issues of reliability and missing values.

To distinguish education levels, Eurostat follows UNESCO's (2012) classification. Specifically, the education level is designated as high if it corresponds to ISCED levels 6 to 8 (tertiary education: from bachelor's degree to doctorate or equivalent), medium if it corresponds to ISCED levels 3 to 5 (upper secondary to post-secondary education, including short tertiary education), and low if it corresponds to ISCED levels 0 to 2 (pre-school to lower secondary).

Regarding the correlation analysis, the research at hand statistically associates the LQ values of the above analysis with crucial factors underlying the geographical allocation of skills as noted in the relevant literature (e.g. Cedefop, 2010). Specifically, it links the LQ_L, LQ_M, and LQ_H with regional and national GDP (both total and per capita), the European Commission's Regional Innovation Index, urbanization levels,[2] the Ageing Index,[3] and the Dependency Index[4] (see Table 1). All metrics were retrieved from Eurostat and were calculated for the years 2009 and 2021 at the regional level, except for the Regional Innovation Index, which was retrieved from the European Commission[5] and is available only for 2021. The value of the correlation coefficient (Pearson's r) between two variables ranges from -1 to 1: a coefficient of +1 shows a perfectly positive linear correlation, while a coefficient of -1 shows a perfectly negative linear correlation. A value of 0 means that there is no correlation between the two variables tested (Gialis & Taylor, 2016).

An analysis of highly educated workers per occupational skill level from a cross-regional perspective

Highly educated workers in low skill-level occupations

LQ_L shows the relative regional concentration of highly educated employed persons in low skill-level occupations. Paradoxically, in both Figure 2a and Figure 2b, LQ scores fluctuate exclusively above 1, indicating over-concentrations in all regions for which data were available. The reason for this is because the phenomenon of highly educated workers being employed in low skill-level occupations is inherently limited. As a result, regions with a small number of such workers, which would exhibit LQ scores below 1, have a non-statistically significant sample, thus data for them is missing. Conversely, the available data allows for observing where highly educated workers are over-concentrated in low skill-level occupations. As such, in 2009, ove-rconcentration of this phenomenon was mostly observed in Île-de-France (LQ=2.62) and in the southern regions of France, namely the agricultural regions of Midi-Pyrénées (LQ=3.42) and Auvergne (LQ=3.83), in the affluent region of Rhone-Alpes (LQ=2.36), and in the touristic region of Provence-Alpes-Côte d'Azur (LQ=2.52). Similar trends can also be observed in Thuringia (LQ=2.21), a region in Germany known for its university, the Greek capital region of Attiki (LQ=1.97), and the capital region of Bulgaria Yugozapaden (LQ=1.81). For 2021, we can see that in all French regions for which data are available LQ values are particularly high (above 2.15). Other regions with even higher LQ values are Hovedstaden (LQ=3.30) and Midtjyllan (LQ=3.25) in Denmark.

Highly educated workers in medium skill-level occupations

LQ_M for 2009 shows that five German regions (Leipzig, Chemnitz, Brandenburg, Dresden, Mecklenburg-Vorpommern and Dresden) stand out in terms of concentrating highly educated workers in medium skill-level occupations, with LQ values around 1.30. Additionally, three regions in the southern part of France (Midi-Pyrénées, Languedoc-Roussillon, Provence-Alpes-Côte d'Azur) exhibit a similarly mild over-concentration. All other regions stay close to the aggregate average of the countries under study. In the regions related to the ReERUA

[2] i.e., population density.

[3] Ageing Index: (Population 65+)/(Population 0-19)

[4] Dependency ratio: [(Population 65+) + (Population 0-19)] / (Population 20-64)

[5] European Commission, 2022. *Regional innovation scoreboard*. Retrieved from https://research-and-innovation.ec.europa.eu/statistics/performance-indicators/regional-innovation-scoreboard_en

Table 1. Correlation matrix of several factors that influence the spatial allocation of workforce skills. *Source: Own elaboration based on Eurostat and European Commission data.*

concentrations of skil (mis)matches	LQ_H (2009)	LQ_H (2021)	LQ_M (2009)	LQ_M (2021)	LQ_L (2009)	LQ_L (2021)	LQ_H (2021-2009)	LQ_M (2021-2009)	LQ_L (2021-2009)
underlying factors									
pc GDP national (2009)	0.34	0.30	0.15	-0.33	0.16	0.26	0.00	-0.37	0.12
pc GDP national (2021)	0.39	0.28	0.23	-0.60	0.16	0.11	-0.13	-0.64	-0.01
pc GDP national (2021-2009)	0.35	0.18	0.26	-0.78	0.12	-0.09	-0.25	-0.82	-0.17
total GDP national (2009)	0.20	0.16	0.49	-0.42	0.09	-0.15	-0.05	-0.64	-0.20
total GDP national (2021)	0.19	0.11	0.46	-0.49	0.08	-0.20	-0.12	-0.68	-0.24
total GDP national (2021-2009)	0.16	0.01	0.40	-0.59	0.06	-0.29	-0.24	-0.73	-0.30
total GDP regional (2009)	0.55	0.58	0.23	0.00	0.47	0.30	0.14	-0.14	-0.06
total GDP regional (2021)	0.57	0.58	0.24	-0.07	0.48	0.27	0.11	-0.20	-0.10
total GDP regional (2021-2009)	0.57	0.53	0.23	-0.24	0.46	0.16	0.02	-0.34	-0.18
pc GDP regional (2009)	0.50	0.50	0.06	-0.30	0.29	0.25	0.08	-0.30	0.01
pc GDP regional (2021)	0.54	0.47	0.16	-0.50	0.29	0.13	-0.03	-0.52	-0.09
pc GDP regional (2021-2009)	0.48	0.34	0.26	-0.68	0.23	-0.06	-0.18	-0.73	-0.22
Innovation Index (2021)	0.58	0.44	0.37	-0.36	0.37	0.15	-0.15	-0.52	-0.13
Urbanization (2009)	0.43	0.35	0.01	-0.11	0.16	-0.05	-0.06	-0.09	-0.16
Urbanization (2021)	0.43	0.36	0.00	-0.11	0.16	-0.05	-0.06	-0.10	-0.16
Urbanization (2021-2009)	0.40	0.35	-0.02	-0.13	0.11	-0.03	-0.02	-0.10	-0.10
Ageing Index (2009)	-0.09	-0.40	0.17	-0.17	-0.09	-0.45	-0.57	-0.24	-0.33
Ageing Index (2021)	-0.30	-0.54	0.06	-0.05	-0.18	-0.42	-0.47	-0.08	-0.25
Ageing Index (2021-2009)	-0.35	-0.14	-0.22	0.25	-0.13	0.16	0.31	0.34	0.24
Dependency Index (2009)	-0.25	-0.08	-0.02	0.17	-0.17	0.25	0.27	0.16	0.35
Dependency Index (2021)	-0.08	0.04	0.14	0.43	-0.08	0.31	0.21	0.29	0.34
Dependency Index (2009-2021)	0.12	0.13	0.21	0.42	0.05	0.19	0.04	0.24	0.13

Project, this type of matching is not extensive. Specifically, under-concentration of this type of skill mismatch is observed in North and South Aegean in Greece and Sjaelland in Denmark, while Freiburg and Île-de-France have values close to 1 (Figure 3a, Annex 1).

In 2021, the overall number of regions exhibiting over-concentration increased. However, Attica stands out (LQ=2.06), as well as the rest of the Greek regions, which show similar trends with the exception of the rural North Aegean (LQ=1.06). German regions have low or close to the aggregate average shares, including Freiburg. The same applies for Denmark; indicatively, the highest value in the country can be found in Hovedstaden (LQ=0.82). In France, most regions exhibit an over-concentration; only seven regions are exceptions to this, having shares close to the aggregate average, including Île-de-France (Figure 3b).

Highly educated workers in high skill level occupations

For 2009, almost all capital regions of the countries under study exhibit notable over-concentrations (1.25 in Yugozapaden, 1.55 in Île-de-France, 1.43 in Berlin and 1.50 in Hovedstaden), except for Attica in Greece, whose share is close to the aggregate average. Most other regions in the countries under study display medium or low LQ scores, with the exception of Leipzig and Midi-Pyrénées (Figure 4a). This pattern remains almost unchanged in 2021. An exception to this is Rhône-Alpes, one of the "four Motors for Europe", which shows an over-concentration of highly educated workers in high-skill level occupations, illustrating the long-standing concentration

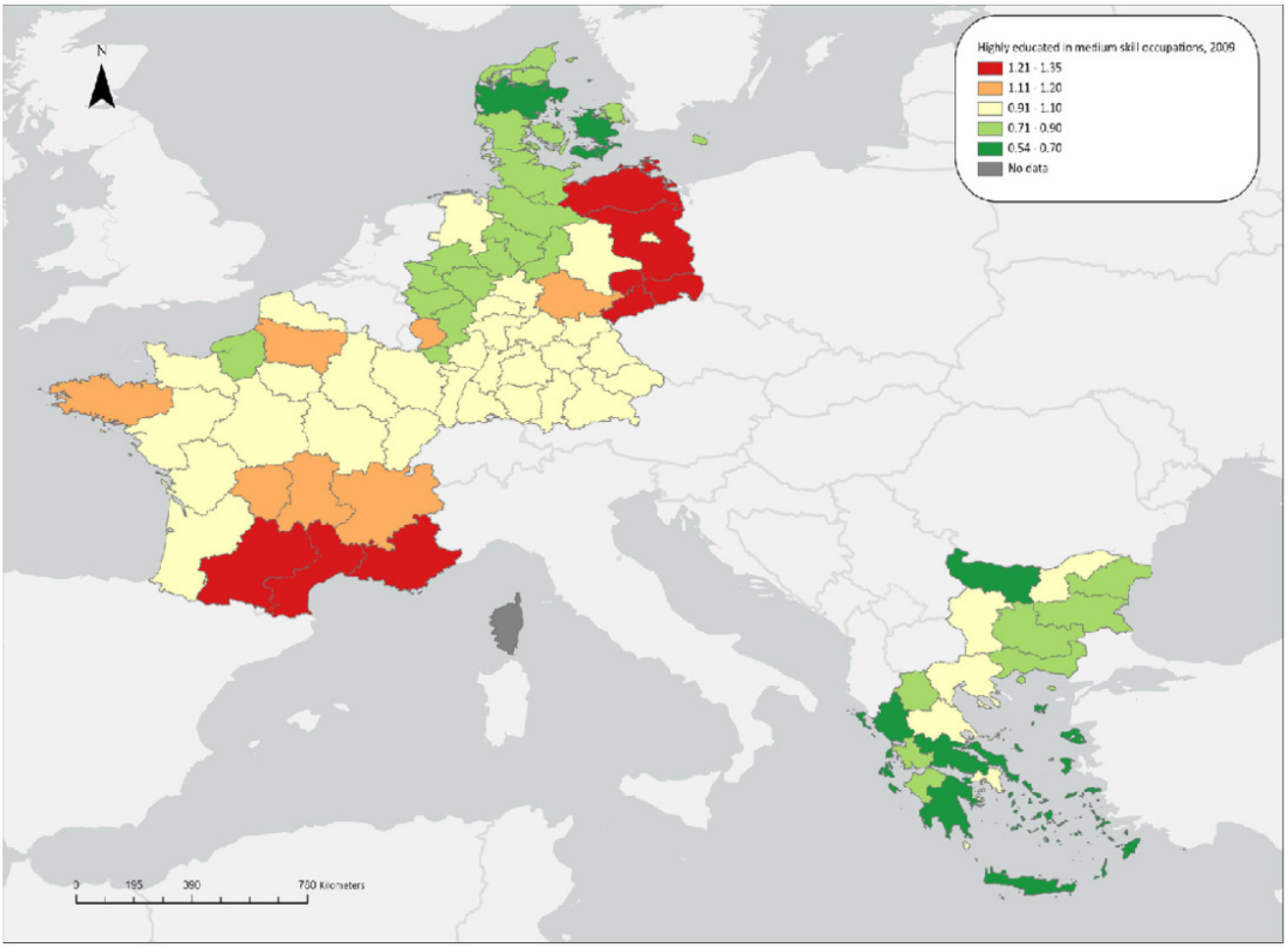

Figure 3a. Over/under concentration of highly educated persons in middle skill occupations, relative regional concentrations, 2009. *Source: Own elaboration based on Eurostat data.*

of these workers in metropolitan, highly industrialized and research-oriented regions. Finally, as far as the ReERUA-related regions are concerned, the remote North and South Aegean exhibit a notable under-concentration (0.69 and 0.58 respectively), Sjlland and Freiburg exhibit average LQ scores, while Île-de-France has the highest value (LQ=1.69) among all regions under study (Figure 4b, Annex 1).

Contextualizing the uneven geography of skill mismatches

The correlation matrix (Table 1) reveals an important correlation between LQ_H scores in 2009 and 2021 and total regional GDP, including the latter's change over the study period (2009–2021). Similar correlations, albeit mostly milder, are observed between LQ_H scores and regional GDP per capita. In contrast, correlations between LQ_H scores and national GDP (both total and per capita) cannot be regarded as significant. The above findings indicate that perfect skill matching can mainly be observed in regions with robust economies, regardless if they are located in countries that are not as economically dynamic. A moderate positive correlation can also be observed between LQ_H scores (for both years under study) and population density in 2009. Although Pearson's R values diminish when looking into the respective correlation for 2021, the importance of urbanization levels in efficient skill matching is nevertheless highlighted. Conversely, a remarkable negative correlation between LQ_H scores and the ageing index is evident in Table 1. In fact, this link is consolidating over time, as it becomes stronger for LQ and the Ageing Index's values in 2021. Another interesting observation is that ageing regions in 2009 were not particularly bad or good in matching workers' skills with occupations, but they eventually proved pretty weak in this regard later on (in 2021). This marks that the age structure at the regional level has become an indicator of skill mismatches, while in our study it appears to also be an indicator of future mismatches. Lastly, there also is a moderate

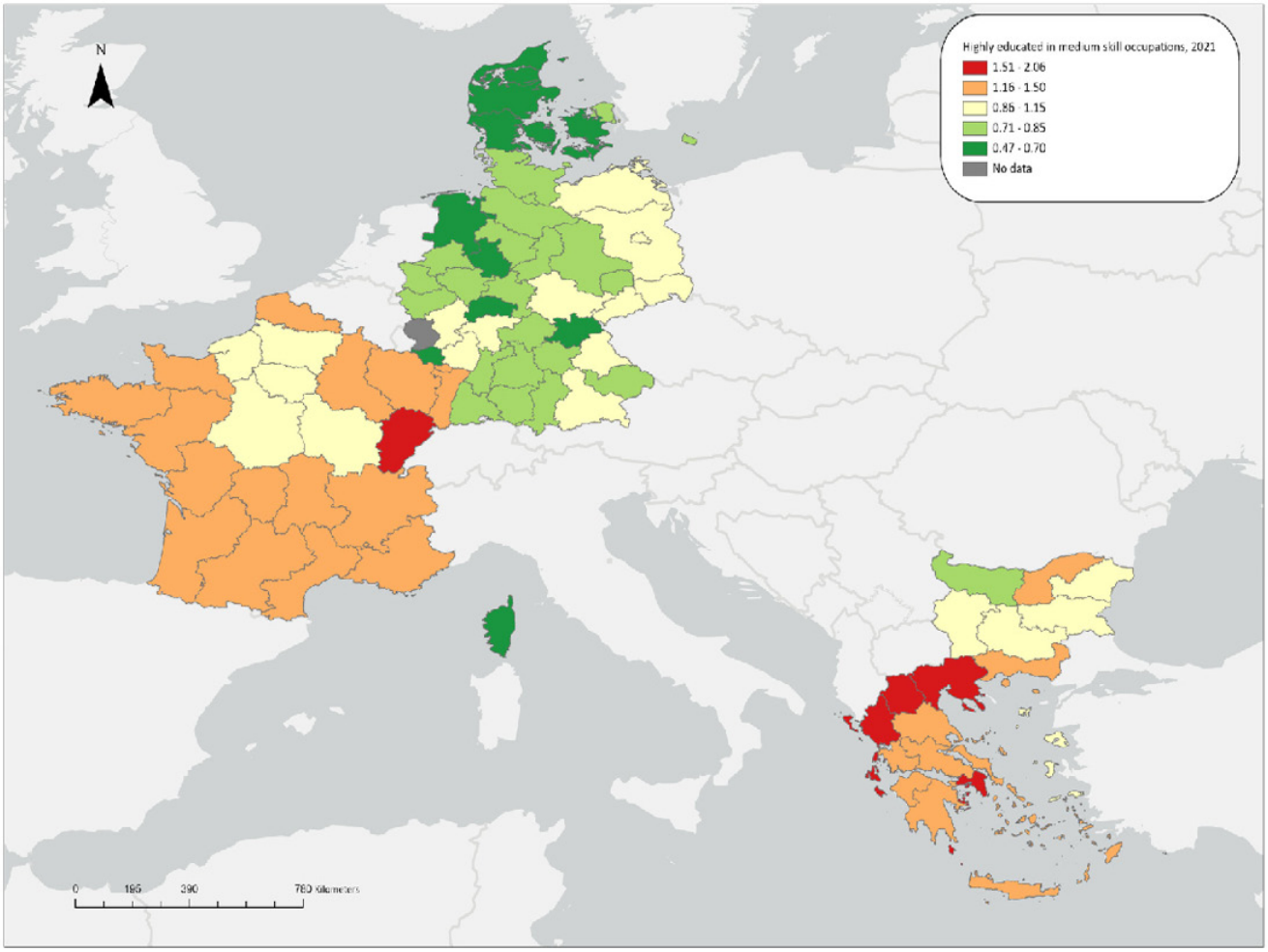

Figure 3b. Over/under concentration of highly educated persons in middle skill occupations, relative regional concentrations, 2021. *Source: Own elaboration based on Eurostat data.*

correlation between the Innovation Index in 2021 and the LQ_H for both years, underlining the importance of a region's innovation capacity in the optimal allocation of talent.

Regarding regional concentrations of highly educated workers in medium skill-level occupations (LQ_M), 2021 scores exhibited a strong negative correlation with national GDP in 2021 (both total and per capita), as well as their change between 2009 and 2021. Interestingly, when it comes to LQ_M in 2009, the respective correlations are instead mildly positive, signifying that many regions within robust national economies struggled to optimally allocate talent at the onset of the 2008/2009 Global Crisis, but gradually, until 2021, they smoothened these mismatches. This is further confirmed by the negative correlation between LQ_M in 2021 and the change of national GDP per capita between 2009 and 2021, which is among the strongest observed in Table 1. The above underlines the importance of national economies in skills' allocation. When it comes to regional GDP, correlations appear similar as above but milder, although that between LQ_M and the change of regional GDP per capita between 2009 and 2021 in particular is strongly negative. Comparing the correlation patterns between LQ_M and various regional and national GDP metrics, it is found that productive robustness at the national level affected this type of skill mismatch more than robustness at the regional level did. For its part, the effect of regional innovation systems was not found to be particularly remarkable. Similarly, the Ageing Index does not appear to correlate strongly with LQ_M, either positively or negatively. Lastly, the Dependency Index's scores in 2021 and their change during 2009–2021 present a mild positive correlation with LQ_M in 2021. The latter indicates that regions with large populations outside productive ages are more likely to concentrate more highly educated workers in medium skill-level occupations.

Regional concentrations of highly educated workers in low skill-level occupations (LQ_L), which is the starkest form of skill mismatch in our study, do not strongly correlate with

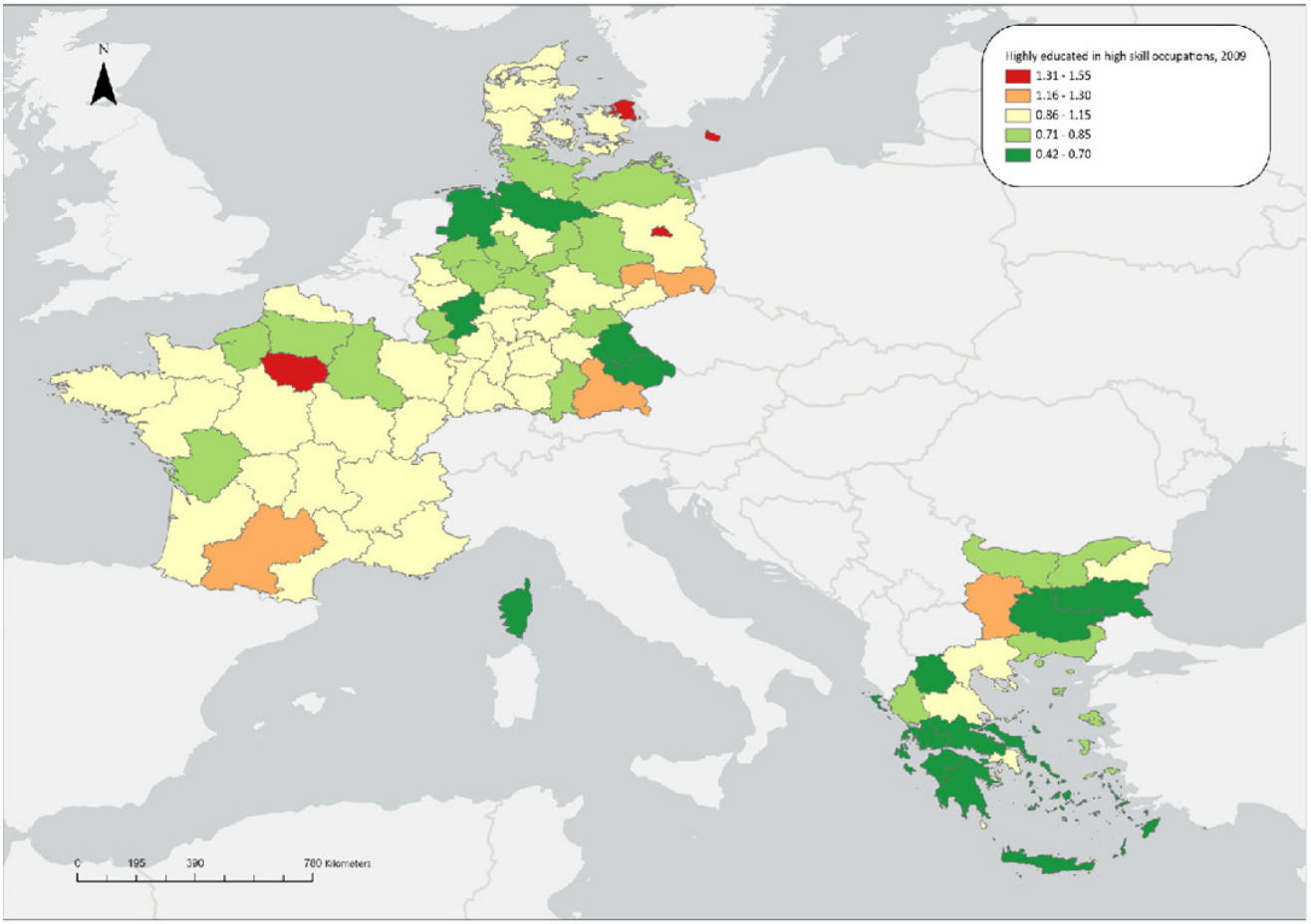

Figure 4a. Over/under concentration of highly educated employed persons in high skill occupations, relative regional concentrations, 2009. *Source: Own elaboration based on Eurostat data.*

metrics related to the national GDP. This means that there are many regions within otherwise robust national economies that exhibited extreme overskilling, as well as regions within meagre national economies with optimal skill matches. Notably, the strongest positive correlations in that part of the matrix can be found between LQ_L and regional GDP, meaning that robust regional economies tend to suffer from overskilling. However, this does not refer to metropolitan regions, considering the low coefficient values between urbanization levels and LQ_L regardless of the year. Apart from the above, only the Ageing Index displays some notable correlations with LQ_L. Specifically, the index's scores in both 2009 and 2021 (but not their change during 2009–2021) positively correlate mildly with LQ_L in 2021. This suggests that regions with an ageing population tended to concentrate more instances of overskilling then.

It must be noted that the LQ is a relative index, meaning that its changes over time do not indicate neither absolute growth nor retraction of the phenomenon under study. Therefore, correlations pertaining to LQ changes over time must be approached with caution. That being said, LQ_M changes over the study period exhibit particularly high negative correlation with national GDP (both total and per capita). This indicates that regions within robust national economies managed to limit this type of skill mismatches over time in relation to all other regions. Similarly stark negative correlations can be observed between LQ_M and the change of regional GDP per capita during the study period; namely, regions which increased their GDP per capita limited the relative concentration of such workers. Despite the LQ being a relative index, the above shows how important the relationship between macroeconomic metrics (measuring the overall size of a national/regional economy and the standard of living of citizens therein) and the optimal allocation of skills is. For example, the Greek regions (Figure 3b), where LQ_M increased significantly in 2021 compared to 2009, national and regional GDP also decreased significantly.

Discussing the determinants of human capital allocation

Our analysis above highlighted the uneven geography of skill and education levels' matching across the regions in five countries

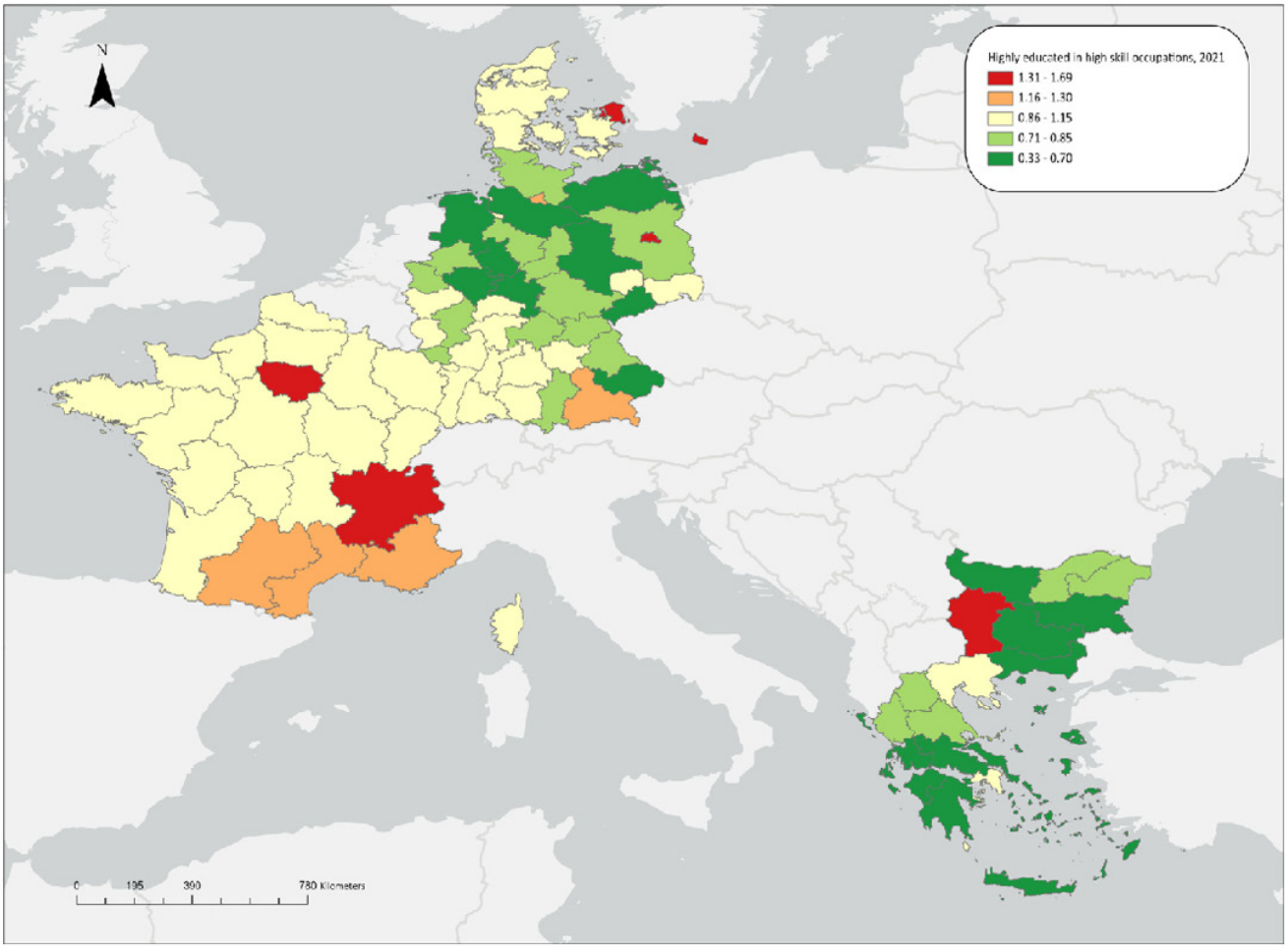

Figure 4b. Over/under concentration of highly educated employed persons in high skill occupations, relative regional concentrations, 2021. *Source: Own elaboration based on Eurostat data.*

representing Europe's main employment/education regimes. To better contextualise our findings, we also conducted a correlation analysis between the concentrations of all types of skill (mis)matches and various metrics that the relevant literature has indicated as significant. Drawing upon our main findings, here we discuss the most crucial factors underlying the uneven geography of skill mismatches. In this framework, we put particular emphasis on the economic dynamism of national economies, regional industrial structures, urbanization, local institutional structures and practices, and demographic structures, drawing from the main findings of the relevant literature (Alamá-Sabater *et al.*, 2024; Cedefop, 2010).

First, there are multiple indications that the **dynamism of national economies** is a prime determining factor for the spatially uneven distribution of human capital and skills' matching. In our study, this dynamism's role in human capital allocation is reflected in the negative correlation between national GDP and LQ_M. Indeed, robust national economies, both in terms of total and per capita GDP (Germany, Denmark, France), were found to overall exhibit more notable concentrations of highly educated workers in high skill positions than less dynamic ones (Bulgaria, Greece). Additionally, a closer look reveals that the former countries have oriented their production towards dynamic sectors comprising high added value manufacturing, financial services, and other specialized B2B services, in a more decisive way than the latter ones (Herod *et al.*, 2021). As such, beyond exhibiting more efficient skill matching, countries with dynamic sectoral specializations concentrate much higher shares of a high-skilled workforce in the first place (Lee & Rodriguez-Pose, 2013).

The reason that some countries can attract or develop a workforce with a higher skill set whereas others struggle to follow cannot be seen independently of a broader context pertaining to their positioning within global value chains (henceforth GVCs). The very constitution of "sequential structures" such as GVCs implies uneven development: some countries get to host the strong links of these chains—i.e., the activities of higher value added which demand skilled labour—whereas the rest

are left with the weaker ones (Smichowski *et al.*, 2016). Within a value chain, a higher value added is typically attributed to the initial-stage and the later-stage activities, whereas those in the middle are lower value added (forming a "smiley face" curve; Mohiuddin & Su, 2014). Specifically, activities which come first in production chains relate to the standardization, innovation, and design of a product, activities coming afterwards include the manufacturing and assembly of a product, and activities that come last relate to logistics, marketing, and branding (Fróes de Borja Reis & Barroso de Souza, 2018).

As such, it is commonly accepted that already advanced economies achieve a better positioning within these complex structures. This brings upon them a series of positive outcomes, including being able to improve productivity through attracting high-skilled labour (Fernandez-Stark *et al.*, 2011). Moreover, this positioning is clearly reflected in country-level differences in education systems, which allows benefited countries to better develop high-skilled labour in the first place. As mentioned above, the countries that we study follow different educational paths that have a direct impact on the labour market. For example, the *universalistic* (e.g.Denmark) regime with high investments in education and fast and stable school-to-work transitions is completely different from countries of the *sub-protective* regime (e.g. Greece), which display severe skills mismatches and low labour demand in general (Hadjivassiliou *et al.*, 2019).

Beyond the national scale, positioning within GVCs translates in profoundly different ways at the regional level as well (Fernandez-Stark *et al.*, 2011). Characteristically, stark inequalities among regions regarding skill and education matching were found in Germany and France despite being strong national economies overall, while instances of a great matching were identified within lagging national economies, as in the case of Bulgaria's and Greece's capital regions (Yugozapaden & Attica respectively). For one, this observation underlines how robust regions within a less robust national context over-concentrate capital and activities at the expense of their surrounding regions. Such a case is Yugozapaden in Bulgaria, with an LQ_H score of over 1.31 in 2021. Interestingly, the same applies even in Germany, France, and Denmark, although to a lesser extent. Indicatively, LQ_H was found to be particularly high in Berlin (Germany) and Hovedstaden (Denmark), while many regions in these countries did not perform as well. The above helps us to—at least partially—refute theoretical and empirical postulations around the spillover effect of growth poles (see Florida *et al.*, 2008).

Overall, the above highlights the importance of **regional industrial specializations** and **innovation capacity**, which are deeply interconnected. Specifically, beyond the correlation between LQ_H and regional GDP, our analysis documented the statistical significance of the Innovation Index's scores. As shown, then, not only is the size of a regional economy or the standard of living of its citizens important in the optimal allocation of human capital, but also regional innovation performance. Regions which for example host innovation research centres or constitute strong logistic centres are positioned in better terms within the global geography of skills, whereas those which constitute manufacturing/assembly centres are positioned in worse terms (Cedefop, 2018), except for the case of particularly high added value products (e.g., biotech; Mohiuddin & Su, 2014). In our analysis, regions standing out in terms of matching highly educated workers with high skill occupations included Île-de-France, Berlin in Germany, and Hovedstaden in Denmark. All of the above constitute innovative regions with a high GDP per capita; for instance, Île-de-France is an innovation leader at a pan-EU level (European Commission, 2022). Similarly, Yugozapaden, which also exhibited a notable high skill/education matching, has taken significant steps towards economic modernization and technological improvement in recent years (European Commission, *ibid*).

Nevertheless, regions cannot upgrade within GVCs completely detached from their broader national context, especially if this refers to an obsolete domestic economic system (Gereffi & Lee, 2016). This postulation is indicated by the concentrations of highly skilled workers in middle skill level occupations, which reflects some extent of skill mismatching. Specifically, all Greek regions displayed relevant over-concentrations, with Attica standing out among all study regions. This reflects the weaker productive structures of Greece as a whole as well as its regions. For instance, the North Aegean specializes in small-scale agriculture, while the other insular regions in the country overfocus on tourism (Herod *et al.*, 2022). Even the country's capital region is only a moderate innovator, lagging significantly in terms of R&D spending (European Commission, 2022). Apart from tourism, there are many manufacturing- and assembly-related activities along GVCs that favor medium skill-level occupations and therefore generate tendencies towards a disproportionate amount of highly educated workers in such occupations. Such is the case with most French regions, and especially the agri-food heavy Franche-Comté.

Of course, beyond a current positioning within broader GVCs, these industrial specializations at the national and regional level also reflect a historical context, including the effect of long structural transformations and abrupt crises. Specifically, in the aftermath of the crisis of Fordist industrialization during the 1970s, regions in Northern and Central Europe took a turn toward technologically advanced sectors; in contrast, being unable to maintain their export capacity, peripheral regions across Southern Europe saw their industrial systems dismantled and resorted to less innovative, constructions-driven growth models (Herod *et al.*, 2021). Moreover, the 2008/09 Global Crisis put a heavy strain on the peripheral parts of the EU and led to the burst of the real estate bubbles they had developed, decimating their construction activity (Gourzis & Gialis, 2019). However, having their industrial structures already dismantled, these regions followed a course further into deindustrialization, gradually developing a heavy dependence on tourism activities (Herod *et al.*, 2022). As a result, their

economic base in recent years comprises a mix of less innovative, technologically backward sectors such as construction, retail, and low value-added market services (Fana *et al.*, 2016).

In further examining the determinants of skill (mis)matches, closely related to industrial specializations is the **extent of urbanization**. As the analysis revealed, there is a positive moderate correlation between the LQ_H and the population density, showing that urbanization is important in human capital allocation. Regions with dynamic metropolitan areas typically abound in occupations requiring higher skill levels, thus, demand for skilled labour is high there (Psycharis *et al.*, 2014); on the other end, urban environments often constitute more attractive environments for a high skilled and creative labour force as they are characterized by more amenities—cultural, transportations-wise, choices for education, etc.—and lower entry barriers for newcomers (Florida *et al.*, 2008). This is rather expected, since large urban agglomerations act as dominant poles, accumulating population and capital, concentrating the better part of domestic infrastructure, and attracting foreign investments (Perroux, 1955), eventually fueling processes of self-sustained growth (Polyzos, 2015). Nevertheless, our analysis highlighted a mild positive correlation between population density and perfect skill matching (LQ_H), as well as no negative correlation between density and LQ_L and LQ_M. This indicates that, instead of metropolitan regions in general, it was mostly the capital regions within each country that exhibited a good performance in skill matching. In fact, many metropolitan regions were found to simultaneously display over-concentrations of highly educated people in low-skill occupations, as for instance Île-de-France. This is a particularly important observation, as it implies deep cutting inequalities and fierce competition even within the most dynamic regional labour markets, which have in fact exacerbated during the 2010s recession (Herod *et al.*, 2021). Indeed, the relevant literature has noted that urbanized regions exhibit highly polarized labour markets (Capsada-Munsech & Valiente, 2020). Namely, besides the core of well-qualified people working in high skill occupations, there is a periphery of precarious workers undertaking menial tasks (Teixeira, 2022). Moreover, with super-star cities within robust national economies and capital cities within smaller national economies concentrating a larger highly educated workforce than what their labour markets can absorb, and thus channeling it to lower skill-level occupations, the simultaneous high scores in LQ_H and LQ_L cannot be seen as a paradox.

Nevertheless, it is not central metropolitan areas that were found to exhibit the starkest overskilling (LQ_L) but those around them. Aside from some robust regions then, overskilling is so widespread that one out of four university graduates in the EU works in jobs requiring lesser skills than what they have acquired through their education (Cedefop, 2018). Moreover, this phenomenon is persisting, as skill mismatches in most peripheral regions do not solely emerge in times of economic turbulence, but they constitute diachronic traits (Iammarino *et al.*, 2019); this is despite approaches such as HCT postulating that overskilling cannot persist in the long run and that it is automatically balanced out by market mechanisms (McGuinness & Pouliakas, 2016). Even worse, beyond being unable to attract high skilled labour so as to cover their needs, most peripheral regions also appear unable to keep the one they have developed (Florida *et al.*, 2008). In this context, apart from extensive overskilling, they also suffer from extensive underskilling as well (Lee & Rodriguez-Pose, 2013). As such, they enter a vicious cycle of deepening skill mismatches. This self-regenerating vulnerability comes in stark antithesis with the virtuous cycle of self-sustained growth in dynamic regions. Combined, these cycles make clear that—in the absence of decisive institutional interventions—spatial inequalities tend to deepen instead of being ameliorated over time (Teixeira, 2022).

Therefore, the link between peripherality and skill mismatches highlights the importance of **local institutional structures and practices**, which are particularly weaker in peripheral regions (Herod *et al.*, 2022). Weak market and state institutions bring a series of consequences. For one, they can influence entrepreneurial activities (Junaid *et al.,* 2022). In fact, "institutional sclerosis", namely entrenched interest groups within weak institutions, has long been accused of impeding economic growth by resisting changes that could disrupt their established benefits, and leading to economic stagnation and less innovation (Olson, 1982). Moreover, weak institutions lead to "information asymmetries" among graduates, leading to poor career choices (McGuinness *et al.*, 2018). In our analysis, although an indicator of effective governance was not included, proxies such as GDP and the Innovation Index were found to be positively correlated with LQ_H and negatively with LQ_M.

One last decisive difference between urbanized and rural areas that has to be taken under consideration is their **demographic structure**. Our analysis revealed a negative correlation between the LQ_H and the Ageing Index and a mild positive correlation between the LQ_M and the Dependency Index. However, the relationship between allocation of talent and demographics is more complex. What cannot be reflected in our analysis—and most other secondary ones—is that older workers generally lose their incentive to retrain over time, with the introduction of new technologies rendering their skill sets obsolete (McGuinness *et al.*, 2018). At the same time, the weight of meeting skill demand falls upon the shoulders of those entering the labour market, who must develop the appropriate competencies (Cedefop, 2015). Amid intensified competition, younger people are further pushed to invest in their training (Brunello & Wruuck, 2021), with education being their main defence mechanism in retaining their place in the job market (Sala, 2011). As such, younger labour markets are not necessarily functioning better in terms of talent allocation.

Conclusions

This study examined the issue of human capital allocation at the regional level across five European countries, which represent key employment models within the EU. Our findings highlighted the uneven geography of skill mismatches, as capital and metropolitan regions were observed to be more efficient

than less affluent and peripheral ones in matching supply (in terms of education attainment level) and demand (in terms of demanded skill-level in occupations), especially when it comes to upper-level skills. To further decipher this remark, we discussed the role of five interrelated factors: economic dynamism at the national level, regional sectoral specializations, urbanization, institutional structures, and demographic trends. In this framework, we briefly discussed the role of regions' positioning within broader structures such as GVCs. Importantly, our analysis pinpointed that human capital is shaped by multiple forces at the same time, most of which relate with each other in a dialectical way. Furthermore, we identified a series of self-sustained, regenerating processes of resilience and vulnerability, i.e., virtuous and vicious cycles. Ultimately, we found human capital to be of the utmost importance in regional development. Although it can generate spatial growth, its concentration in certain areas leaves lagging regions out of growth pathways.

To break this pattern of uneven development, policy interventions are required. Thus, here we recommend a series of actions drawing upon the five factors discussed above, while taking into account the EU's "New Skills Agenda". Our recommendations have been tailored for the regions associated with the ERUA but can be applied to other contexts as well, given that these regions represent Europe's key employment regimes. Looking at the local institutional structures and practices, in the regions with strong research and academic activity like the ones related to the consortium, it is important that their universities work together with stakeholders from industry to **spill over knowledge and cover the research and innovation needs** of the labour market. In this frame, learning events for reskilling and upskilling in emerging sectors—e.g., green skills—are necessary. In addition, high quality career counselling is key, especially for vulnerable groups such as the youth, women, and migrants, for not only making sensible early career decisions but also in overcoming career challenges throughout their lives (Papakota, 2016). In fact, as noted above, such career counseling is more than necessary in peripheral regions, where career choices are less informed due to "information asymmetries" (McGuinness *et al.*, 2018). In this context, educational structures such as schools, universities or vocational training centres should respond to the needs of students at different stages of career development by identifying skills, experiences, values and personality traits of graduates, technological trends and employment opportunities, employers' expectations and career planning (Litoiu & Oproiu, 2012). Lastly, tighter networks of social, scientific, and policy-related stakeholders should be encouraged, so that through joint actions they engage in labour market forecasting and early identification of skill shortages.

Regarding the spatially uneven distribution of human capital due to national economies' dynamism (or lack thereof) or regional industrial specializations, it can be addressed through targeted investment incentives and guided industrial reorientation. Governments can **rechannel entrepreneurial activity into underdeveloped regions** through financial incentives like tax breaks, grants and subsidies. More crucially, countries and regions with economies entirely oriented towards medium and low-skill sectors (e.g., tourism) that generate mainly low-quality jobs, should pursue a **re-specialization in more dynamic high value-added and high-skill sectors** (Emmanouil *et al.*, 2024); this should reduce spatial and talent inequalities. Furthermore, our analysis showed that high skills increase inversely with population ageing and are positively associated with the degree of urbanization; as such, investment in education, training, and continuous learning, or policies promoting economic resilience and adaptability, may not be sufficient in rural and underdeveloped regions. This highlights the need for a move away from a horizontal implementation of policies, which is the case with many EU initiatives such as the Youth Guarantee (Emmanouil *et al.*, *ibid*). Instead, policies should be spatially sensitive so as to keep young people with high levels of education in non-urban and/or peripheral regions, where they will work in high-skill occupations and put their human capital in good use. Taking into account the specific needs of regions, promoting innovation, incentivizing investment, and sharing best practices, can therefore promote balanced economic growth and reduce inequalities in the geographical distribution of skills.

Annex

Annex 1. Share of highly educated workers in low, medium and high skill-level occupations, per region, 2009 and 2021.
Source: Eurostat.

Region	Year	% Low skills	% Medium Skills	% High skills
BG34	*2021*	13,86	58,55	26,53
	2009	14,51	62	22,2
BG41	*2021*	7,85	44,55	47,6
	2009	11,06	49,67	38,4
BG33	*2021*	17,44	54,01	28,55
	2009	14,07	57,61	28,32
BG31	*2021*	12,96	60,27	26,77
	2009	13,05	61,52	25,43
BG42	*2021*	11,64	62,8	24,33
	2009	12,52	63,11	23,67
BG32	*2021*	10,73	61,98	27,29
	2009	11,44	60,77	27,79
DK04	*2021*	10,74	41,96	47,3
	2009	10,19	46,37	43,44
DK02	*2021*	10,83	45,25	43,93
	2009	8,94	46,98	44,08
DK01	*2021*	7,38	31,52	61,09

Region	Year	% Low skills	% Medium Skills	% High skills
	2009	7,97	36,25	55,78
DK05	*2021*	11,91	45,86	42,22
	2009	10,7	48,64	40,66
DK03	*2021*	12,95	44,03	43,02
	2009	11,49	50,06	38,46
DE92	*2021*	8,46	45,32	46,22
	2009	7,93	46,29	45,78
DEB1	*2021*	9,6	48,78	41,62
	2009	9,32	50,74	39,17
DEC0	*2021*	7,79	48,52	43,69
	2009	9,21	51,02	39,77
DE26	*2021*	6,95	46,87	46,18
	2009	9,11	50,83	40,06
DE60	*2021*	5,12	37,23	57,65
	2009	6,58	40,22	53,2
DEB2	2021	12,89	39,27	47,84
	2009	9,06	50,08	40,86
DE50	*2021*	10,04	44,81	45,15
	2009	9,56	48,65	41,79
DED5	*2021*	4,81	41,12	54,07
	2009	8,16	48,21	43,63
DEB3	*2021*	7,44	45,36	47,2
	2009	8,92	46,77	44,31
DE30	*2021*	4,19	35,33	60,48
	2009	7,06	38,59	54,36
DE11	*2021*	7,85	44,67	47,48
	2009	7,91	46,83	45,26
DE80	*2021*	6,18	52,19	41,62
	2009	7,54	55,6	35,92
DEE0	*2021*	7,12	53,92	38,96
	2009	8,25	53,19	37,85
DEG0	*2021*	7,56	51,55	40,89
	2009	7,42	53,63	38,44
DEF0	*2021*	7,28	47,09	45,64
	2009	8,36	47,95	42,9
DE12	*2021*	7,78	43,89	48,33
	2009	8,33	46,5	45,17

Region	Year	% Low skills	% Medium Skills	% High skills
DE21	*2021*	5,45	40,93	53,62
	2009	6,63	43,44	49,64
DE93	*2021*	8,44	48,72	42,84
	2009	8,68	50,65	39,94
DE94	*2021*	8,57	51,58	39,85
	2009	9,62	53,06	36,58
DE22	*2021*	7,04	52,22	40,74
	2009	9,88	55,55	34,57
DED4	*2021*	5,34	55,53	39,13
	2009	6,21	54,26	39,52
DE23	*2021*	7,87	51,29	40,84
	2009	9,28	54,68	36,03
DE25	*2021*	6,74	46,42	46,85
	2009	8,31	47,79	43,9
DE40	*2021*	6,02	49,86	44,11
	2009	7,18	51,48	41,34
DEA3	*2021*	7,58	47,63	44,79
	2009	8,36	51,13	40,5
DEA5	2021	8,08	48,99	42,94
	2009	9,24	49,83	40,93
DE73	*2021*	8,05	49,6	42,35
	2009	10,68	48,65	40,67
DE91	*2021*	7,32	47,04	45,64
	2009	8,54	50,49	40,97
DEA1	*2021*	6,78	45,73	47,49
	2009	7,49	47,87	44,64
DE24	*2021*	7,1	46,76	46,14
	2009	9,97	50,62	39,41
DE14	*2021*	7,81	46,68	45,52
	2009	9,09	49,38	41,53
DED2	*2021*	3,69	49,91	46,39
	2009	8,35	49,75	41,9
DE71	*2021*	7,68	42,98	49,34
	2009	7,57	43,75	48,68
DE13	*2021*	7,79	48,34	43,88
	2009	8,08	50,08	41,84
DE27	*2021*	7,31	50,58	42,11
	2009	7,9	54,06	38,04

Region	Year	% Low skills	% Medium Skills	% High skills
DEA4	*2021*	8,61	48,92	42,48
	2009	10,14	50,61	39,25
DE72	*2021*	7,71	44,22	48,07
	2009	8,96	48,88	42,16
DEA2	*2021*	6,84	43,23	49,94
	2009	7,78	44,44	47,44
EL63	*2021*	6,23	71,36	22,4
	2009	4,95	65,64	28,78
EL41	*2021*	7,13	62,31	26,54
	2009	4,93	51,11	37,53
EL51	*2021*	7,81	65,77	19,59
	2009	4,96	63,82	27
EL62	*2021*	14,04	68,91	17,06
	2009	7,3	66,53	26,17
EL54	*2021*	10,9	63,25	25,85
	2009	6,19	65,78	28,03
EL30	*2021*	5,1	52,13	40,96
	2009	8,34	50,8	39,52
EL52	*2021*	6,3	61,34	31,01
	2009	6,49	58,1	34,66
EL53	2021	5,55	68,02	26,43
	2009	4,75	66,72	28,53
EL65	*2021*	6,55	70,5	22,95
	2009	6,87	68,08	25,05
EL43	*2021*	7,96	66,01	25,35
	2009	7,53	62,62	29,28
EL64	*2021*	10,22	69,98	19,8
	2009	9,23	64,08	26,68
EL61	*2021*	6,21	62,34	29,99
	2009	6,15	60,33	32,83
EL42	*2021*	5,86	65,97	27,01
	2009	9,67	61,19	29,14
FRI1	*2021*	8,5	44,63	44,98
	2009	8,08	48,99	42,35
FRF1	*2021*	10,11	46,34	43,55
	2009	7,32	50,89	40,92
FRB0	*2021*	10,35	46,47	42,52
	2009	8,3	50,41	40,19

Region	Year	% Low skills	% Medium Skills	% High skills
FRC1	*2021*	10,25	44,24	45,51
	2009	9,75	54,71	35,55
FRG0	*2021*	8,95	48,41	42,13
	2009	8,03	55,26	36,26
FRJ2	*2021*	8,58	40,28	50,44
	2009	8,47	48,91	42,62
FRF3	*2021*	11,37	47,69	40,2
	2009	9,83	54,17	33,51
FRF2	*2021*	9,23	51,32	38,05
	2009	10,06	57,59	32,35
FRE2	*2021*	8,76	47,05	44,19
	2009	9,83	56,54	33,62
FRJ1	*2021*	9,14	41,16	48,9
	2009	9,79	50,11	38,1
FRD2	*2021*	8,24	47,83	43,92
	2009	11	52,66	36,34
FRE1	*2021*	10,11	43,53	46,37
	2009	10,39	50,27	39,34
FRK2	*2021*	7,86	41,04	51,1
	2009	10,47	49,26	39,94
FRK1	*2021*	8,87	52,12	39,01
	2009	9,98	51,14	38,88
FRC2	2021	6,89	54,85	38,26
	2009	8,87	55,5	35,63
FRD1	*2021*	7,86	50,79	41,35
	2009	8,79	54,72	36,49
FRL0	*2021*	9,4	40,67	48,39
	2009	12,41	48,48	37,93
FRH0	*2021*	9,58	45,62	43,19
	2009	8,79	53,07	37,14
FR10	*2021*	6,31	31,07	62,38
	2009	9,6	35,02	54,68
FRM0	*2021*	6,37	51,11	42,52
	2009	13,79	53,25	32,96
FRI2	*2021*	10,6	45,84	43,56
	2009	8,72	55,3	35,97
FRI3	*2021*	11,84	47,83	40,33
	2009	9,27	56,71	32,93

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✔ **Vidmantas Tutlys**
Vytautus Magnus University, Kaunas, Lithuania

The article presents highly interesting and valuable contribution to the research and practice. The provided findings on geographical aspects of skills mismatches are particularly valuable for the articulation of the EU, national and regional strategies and policies of the human capital development.
Research parameters are well defined; research methodology is well founded. The findings are relevant and presented in the well-structured way. The article speaks to the broad audience of researchers, policy makers and other stakeholders.
The only missing aspect is consideration of the implications of the national and region-specific institutional settings and models of skill formation and employment for the skill matching in the analysed regions. But this could be treated as one of the future research areas.

Is the work clearly and accurately presented and does it engage with the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

Are all the source data and materials underlying the results available?
Partly

If applicable, is the statistical analysis and its interpretation appropriate?
Yes

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Education sciences, research of vocational education and training, development of skill formation systems.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 20 August 2025

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?

Alexander Patt
Institute for Employment Research, Nürnberg, Germany

I have read the revised version of the paper and I think it is considerably improved. There is greater focus on documenting spatial allocation of high skilled workers across the EU and exploring the patterns descriptively. The paper now offers a clearer conceptual overview of the many factors affecting skill allocation and mismatch. The authors are successful in connecting different literatures and highlighting the importance of the topic for further studying and informing the policy making. The points on the importance of quantifying the extent of skill mismatch and unevenness in skills distribution, their implications for individual well-being and regional development, and the interplay between technological change, labour market adjustments, education policy and early labour market transitions are in particular well-made. In the revised version, most terms are now clearly defined and different dimensions of mismatch are delineated. New descriptive results are intriguing and add weight to the discussion but should be interpreted with great caution since no causal interpretation is possible and there are many potential confounders.

I have a few remaining suggestions for improving the empirical part:

- Given fairly large changes in the quotient index over time and a rather moderate adjustment in relative employment shares (as evidenced by Annex Table), it would be useful to mention how much of it is driven by employment growth at the aggregate level, which drives the denominator in the formula, as opposed to region-level changes, which are captured by the numerator. One could for example compare changes in the index with the values obtained by fixing national-level employment shares (the denominator) as they were in 2009 for both time periods.

- I would be cautious about interpreting values of LQ far from 1 as indicators of skill mismatch, as the index is also affected by overall employment size. A low value of LQ_H, for example, could arise due to a relatively small number of high skilled workers present in a region who are nevertheless perfectly matched to high skill-level jobs. This possibility could be investigated by calculating the correlation coefficients between LQ_H, LQ_M and LQ_L (and possibly other

independent indicators of regional skill mismatch).

- I am not sure I understand the nature of the missing value problem (page 8 and Figures 2a, 2b): in the Annex Table, the authors report employment shares of highly educated workers in low skill-level occupations without any missing values. Wouldn't that information be enough to create Figures 2a/2b with values for all regions? Moreover, if total regional employment of highly educated workers is known, one could simply recover ELR from known values of EMR and EHR. Furthermore, It's not clear whether Table 1 uses the full set of regions for reporting correlation coefficients with LQ_L. If this is not the case, the results should be based on the set of regions for which values of LQ_L are known in both time periods, as otherwise they may be driven by changes in the composition of the set of regions.

- Table 1 needs to indicate statistical significance levels of correlation coefficients. Please also report the sample size.

- Weaker correlations with the level of national GDP are not surprising given the nature of the data. I suggest to omit these results due to difficulties of interpreting them and because the analysis already uses GDP per capita which doesn't suffer from comparability issues across countries with vastly different population sizes.

- Instead of calculating correlations with changes in GDP per capita, growth rates (in real terms) should be used as they are independent of the scale.

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Labour economics

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 28 May 2025

https://doi.org/10.21956/openreseurope.21837.r53557

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Martin Henning
Department of Business Administration, University of Gothenburg, Göteborg, Sweden

This is an improved and much more coherent version of the paper. The literature review is much better structured, although readers should be aware that the idea of the theoretical reflection is not to derive testable hypotheses, but to draw up the theoretical context of the paper in line with its explorative aim. Consequently, the data analysis remains overall descriptive and illustrative of some empirical tendencies, rather than evaluating a specific theory.

Among the most interesting empirical patters detected are those pertaining to the capital cities and how many of these “superstar cities” produce dual results in the matching on their local labour markets, in both ends of the labour market distribution. Many results concerning the more peripheral region are informative too. These findings are related both to the broader literature on within-country divergence in Europe, and the one on polarization of labour markets from a geographical perspective.

The processes creating illustrated empirical patterns and correlations could be further discussed. The authors themselves emphasize the ”economic dynamism at the national level, regional industrial specializations, urbanisation levels, demographic structures, and institutional endowments”. These indicators may themselves be correlated. On a higher level of abstraction, the authors discuss the impact of recent decade’s regional alignment with the location structures of global value chains. This argument resonates well with recent arguments relating to the “geography of functions” hypothesis, but remains to be formally tested. Also, in the paper, the mismatch issues arising in peripheral regions are largely attributed to institutional dynamics and an information problem in these regions. These might well be factors that contribute to the identified patterns, but given the structure of correlations, it seems to me that this is more an issue created by the structure of regional growth (or not growth), and not so much of an issue of information about available jobs per se.

In all, the paper gives interesting perspectives on an important regional development problem in the EU, and its variation across regions. What could and should be done about it, apart from implementing place-based approaches trying to facilitate general economic growth and productive transformation, remains largely an open issue. Ultimately, it also comes down to the opportunities that people perceive in various places, to participate in economic production and growth. I therefore remain sceptical to general statements such as “Instead, policies should be spatially sensitive so as to keep young people with high levels of education in non-urban and/or peripheral regions, where they will work in high-skill occupations and put their human capital in good use.“ Given the nature of economic dynamics nowadays, this is much easier said than done, if we also want to keep the good features that an essentially experimental economy comes with.

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Economic geography

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Version 1

Reviewer Report 19 April 2024

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Alexander Patt
Institute for Employment Research, Nürnberg, Germany

The paper offers a perspective on regional allocation of human capital and skill mismatch by discussing different strands of the literature (human capital theory, economic geography, education policy, institutions, etc.) and showing complementary empirical evidence using variation in the location quotient index. The index is based on education shares across three broad occupational groups in NUTS2 regions from a selected group of countries. The authors document considerable regional variation in skill mismatch.

Overall, I found the paper thought-provoking and I appreciated that it drew upon various literatures. However, I am unsure that it is possible to adequately address all questions raised by the paper within the analysis framework chosen by the authors. More specific comments follow.

i) The paper does not separate normative from positive statements in a clear way, while lacking notion of an optimal allocation of talent without which such discussion cannot be done. In the empirical part, the authors focus on vertical mismatch, by which they implicitly mean high skilled workers employed in non-managerial and non-professional roles (ISCO groups below 3). However, such allocation could arise due to a particular industry structure which favours middle-skilled occupations and therefore attracts a disproportionate amount of workers across all skill levels. The paper could be improved by separating the issues of spatial allocation from mismatch, and by corroborating the results on mismatch by other indicators of skill shortages and oversupply, such as rates of return to education, local unemployment rates and job turnover.

ii) The authors' construction of the quotient index assumes that all countries should have similar relative shares of human capital allocation, but this ignores country-level differences in education systems organisation and differences in economic development (as more developed economies tend to have higher investment rates in education in general). For example, vocational education plays a relatively larger role in Germany and provides educational tracks to occupations which would otherwise require a college degree in other countries. Since such country-level differences make the results difficult to interpret, the authors should focus on within-country variation.

iii) While the paper introduces five different factors of regional specialisation, the empirical approach doesn't in fact leave the realm of the neoclassical human capital theory, as it is largely informed by spatial allocation of workers within the standard labour demand framework with regional specialisation. While the authors mention other determinants such as global value chains and local institutions, there is no systematic characterisation of their variation shown with data. The findings on mismatch in particular lack an interpretation supported by documented evidence on country and regional differences along the dimensions considered in the paper. Given limitations of regional data, it is doubtful that it is feasible to discuss all these mechanisms in detail and isolate their effects. However, the paper can still be informative by developing comprehensive descriptive evidence in a systematic way.

iv) The paper omits critical details about the sample construction: it is not clear whether the authors imposed age restrictions, used only full-time or part-time workers, included both genders or only males, included or excluded migrant workers (which can have strong implications for the results). It's also not clear whether nation averages of the shares are weighted. How did the authors handle missing data?

v) I am concerned about specific years chosen for the analysis (2009, 2021) which could affect the results due to strong negative economic shocks which were unevenly distributed. Since the analysis doesn't rely on time variation, the authors should use different years and average the results across 5 or 10 year intervals to reduce noise.

vi) The paper only shows the results for high skilled workers. What about other groups?

Is the work clearly and accurately presented and does it engage with the current literature?
Partly

Is the study design appropriate and is the work technically sound?
No

Are sufficient details of methods and analysis provided to allow replication by others?
Partly

Are all the source data and materials underlying the results available?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
No

Are the conclusions drawn adequately supported by the results?
No

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Labour economics

I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

Author Response 08 Apr 2025

Effie Emmanouil

Dear Reviewer, we would like to thank you for your valuable and insightful comments. We have proceeded with major revisions on our manuscript, following most of your points, which we found well raised. These changes have bolstered our arguments, slightly extending the text's wording, without changing its meaning. Please find below our

responses to your comments in detail.

Reviewer: The paper does not separate normative from positive statements in a clear way, while lacking the notion of an optimal allocation of talent without which such discussion cannot be done.
Author Response: To address the first part of this crucial comment, we rephrased various sections of the manuscript. Now, observations based on empirical evidence are clearly stated, allowing the reader to easily distinguish them from statements which express our opinions. Regarding the lack of the notion of an optimal allocation of talent, we have revised the Theoretical and Conceptual Section of our manuscript. Specifically, in this section we open a whole part where we discuss the factors shaping the uneven geography of skill mismatches writing that: *"To maximize the effects of higher educational attainment, however, talent has to be allocated in an optimal way, namely, a worker must employ their skills in the most appropriate setting. It is then through the optimal allocation of talent that a higher educational attainment level generates individual and social returns (Acemoglu, 1995)."* Further below, the concept is scrutinized in detail, using the appropriate literature. Then, in the Discussion, the concept now plays a key role.

In the empirical part, the authors focus on vertical mismatch, by which they implicitly mean high skilled workers employed in non-managerial and non-professional roles (ISCO groups below 3). However, such allocation could arise due to a particular industry structure which favours middle-skilled occupations and therefore attracts a disproportionate amount of workers across all skill levels. The paper could be improved by separating the issues of spatial allocation from mismatch, and by corroborating the results on mismatch by other indicators of skill shortages and oversupply, such as rates of return to education, local unemployment rates and job turnover.
Author Response: This is a well raised point. However, due to limited space, we could not address both the issues of mismatches' spatial allocation as well as the nature of vertical mismatches. Unavoidably, we relied on secondary data that do not consider the qualitative aspects of these vertical mismatches. Nevertheless, we linked the concentration of various types of skill (mis)matches with a series of factors, including through macroeconomic, population, innovation, and demographic indicators. Please refer to our response to Comment 8 by Reviewer 1. The issue of particular industry structures which favour middle-skilled occupations is addressed in the Discussion. Indicatively, we write: *"Apart from tourism, there are many manufacturing- and assembly-related activities along GVCs that favor medium skill-level occupations and therefore generate tendencies towards a disproportionate amount of highly educated workers in such occupations. Such is the case with most French regions, and especially the agri-food heavy Franche-Comté."*

While the paper introduces five different factors of regional specialisation, the empirical approach doesn't in fact leave the realm of the neoclassical human capital theory, as it is largely informed by spatial allocation of workers within the standard labour demand framework with regional specialisation. While the authors mention other determinants such as global value chains and local institutions, there is no systematic characterisation of their variation shown with data. The findings on mismatch in particular lack an interpretation supported by documented evidence on

country and regional differences along the dimensions considered in the paper. Given limitations of regional data, it is doubtful that it is feasible to discuss all these mechanisms in detail and isolate their effects. However, the paper can still be informative by developing comprehensive descriptive evidence in a systematic way.
Author Response: It is correctly stated that limitations of regional data, as well as the paper's word limitation, did not allow us to make our postulations regarding GVCs more evidence-based. Nevertheless, we addressed your comment by developing comprehensive descriptive evidence in a systematic way around the five factors inquired in the Discussion. Specifically, our Empirical Analysis now provides concrete evidence for our postulations in the Discussion by including a scrutiny of indicators on GDP, innovation performance, population density, and demographic structures. Please refer to our response to Comment 8 by Reviewer 1 for more detail regarding the proxies that we used and the methods we implemented for their analysis. Moreover, all these factors are covered in the Theoretical and Conceptual Section as well. Please refer to our response to Comment 3 by Reviewer 2 for more detail.

The authors' construction of the quotient index assumes that all countries should have similar relative shares of human capital allocation, but this ignores country-level differences in education systems organisation and differences in economic development (as more developed economies tend to have higher investment rates in education in general). For example, vocational education plays a relatively larger role in Germany and provides educational tracks to occupations which would otherwise require a college degree in other countries. Since such country-level differences make the results difficult to interpret, the authors should focus on within-country variation.
Author Response: Although this is a well raised point, the main goal of our analysis was to directly compare the performance of various EU regions in terms of addressing skill mismatches. For that reason, we went with the relative-to-transnational LQ as our main index. Nevertheless, we accept that structural differences between countries make such comparisons a difficult case. Apart from the latter, we are perfectly aware that the LQ can sometimes lead to contradicting results due to not providing a clear view of the absolute magnitude of the phenomenon under study, or due to the modifiable areal unit problem. To overcome all the above, we tried to consider a wide array of country-specific factors when discussing our findings. For instance, we have extensively relied on relevant research around the employment/educational regimes typology. For instance, we write in the revised Theoretical and Conceptual Section: *"Nevertheless, dual educational systems such as Germany's have also been praised for their positive effects in school-to-work transitions, albeit having been oversimplified in the relevant literature (Deissinger, 2015). Similarly praised is the universalistic regime in Nordic countries like Denmark, which invest in human capital and match high levels of educational attainment with demand for such workers (Hadjivassiliou et al., 2019). […] …in statist regimes, for instance, employers are not sufficiently involved in matching skills' demand and supply (Capsada-Munsech & Valiente, 2020). As such, in the sub-protective regime of the Mediterranean EU, in countries like Greece, youth transitions to adulthood are long and problematic (Emmanouil et al., 2023). This leads to a large pool of highly qualified people who either cannot find a job, have a profession for which they are overqualified, or have a profession in a different sector from the one in which they were trained, while at the same time many companies are struggling to fill their vacancies (Biagi et al., 2020)."* Similarly, in the Discussion we write: *"…the universalistic (e.g.Denmark) regime with high investments in education and fast and stable school-to-work*

transitions is completely different from countries of the sub-protective regime (e.g. Greece), which display severe skills mismatches and low labour demand in general (Hadjivassiliou et al., 2019).".

The paper omits critical details about the sample construction: it is not clear whether the authors imposed age restrictions, used only full-time or part-time workers, included both genders or only males, included or excluded migrant workers (which can have strong implications for the results). It's also not clear whether nation averages of the shares are weighted. How did the authors handle missing data?
Author Response: To address this comment, we have added to the Methodological Section that *"Eurostat's sample covers all employed persons of both genders, aged 15 and above. Data imputation methods were not used, given that the extent of missing data is limited and most missing values refer to a specific type of skill mismatch (highly educated workers in low skill-level occupations), making most such methods unreliable."*

I am concerned about specific years chosen for the analysis (2009, 2021) which could affect the results due to strong negative economic shocks which were unevenly distributed. Since the analysis doesn't rely on time variation, the authors should use different years and average the results across 5 or 10 year intervals to reduce noise.
Author Response: This is another excellent point which could lead to very interesting findings. In practical terms, we could add one or two years between 2009 and 2021. However, this could substantially add to the wordage of the manuscript. Moreover, we believe that the years under study as it is allow for a comparison between two crucial moments in the EU's recent history: the onset of a period of successive crises and the onset of a period of a renewed round of pandemic- and geopolitically-induced crises. Moreover, please note that our analysis, given that the LQ is a relative indicator, avoids looking into the changes in the extent of skill mismatches between 2009 and 2021. Relatedly, we note in the Empirical Analysis Section: *"It must be noted that the LQ is a relative index, meaning that its changes over time do not indicate neither absolute growth nor retraction of the phenomenon under study. Therefore, correlations pertaining to LQ changes over time must be approached with caution."* As such, we believe that the noise does not affect the significance of our observations considerably.

Competing Interests: No competing interests were disclosed.

Reviewer Report 02 January 2024

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Martin Henning
Department of Business Administration, University of Gothenburg, Göteborg, Sweden

This article approaches a very interesting and important topic: the geography of skill mismatches in Europe. The article uses quantitative data to map skill mismatches in selected regions, and discusses reasons as to why these geographical variations arise.

In fact, it would benefit the article if it could focus *even more* on this phenomenon and its explanations. The introduction is interesting because it juxtaposes more traditional human capital theory with arguments derived from geographical political economy. However, while one could debate the outcomes of this intellectual tension, this is not really the core of the article (human capital theory is though dismissed as simplistic and positivist – a language I would myself avoid given the convincing literature on the overall benefits of education and higher skills). The focus of the article is not to estimate the benefits from education. Instead, I would wish for a stronger focus on the *geography of skill mismatches* in the introduction. This also would open to the real empirical geographical question in the article – what does the geography of skill mismatches look like, and why do differences between regions arise across Europe?

I would also recommend a revision of the literature review in the same fashion (section: Human capital and its uneven spatial distribution). Right now, this section focuses on human capital theory and some sources of mismatches. The discussion makes a valid point around the importance of institutions (in fact, one could probably argue that labour market and education institutions are among the most variable factors across the countries within the single market). Moreover, the geographical discussion treats the issue of regional divergence and uneven regional development. On this topic, there is already a sizeable literature, and this should also not be the core discussion of this paper. While I would actually like to challenge some of the arguments in a within-European context (for example, that growth is a trade-off between regions, the peculiar connection made between vocational training and precarious labour and the new rounds of “Fordist-influenced spatial organization” – within Europe the Fordist era was in fact characterized by decreasing regional economic disparities), this is besides the point.

Instead, I would like to recommend a stronger focus on the geographies of mismatches and why they arise. The paper would make a stronger contribution if it could remain with this focus. In particular, I would welcome a discussion about the dimensions that the authors later return to as explaining the geography of mismatches: dynamism of national economies, regional specializations, local institutions and demographic structure. In such a context, for example, the discussion about the global production chains and their spatialities is interesting, but it does not quite explain the geography of mismatches.

In the empirical part, the use of the different LQs is ingenious. However, it would be great if the authors could comment on the reliability of the mismatch indicator: is there a risk that we simply misjudged the level of skills needed in jobs, or that they changed? And where in the economy do the most important mismatches arise? I believe that this could be easily described using the available data, as an introduction to the geographical analysis. It would also be good if the authors explained whether the patterns could be taken to be general – or are the results a feature of the regions/countries that selected themselves into the university initiative?

The authors caution a warning for fig. 1.1a and b. It is hard what to make of this – is this part of the analysis reliable or not?

In the discussion section, the authors are looking for different ways to explain the geographical

variation in the mismatches. It would be good to know how the authors ended up thinking about these factors (linking to the theoretical section above). Secondly, it is a bit hard for the reader to evaluate the relevance of the factors. Here, I would recommend the authors to provide empirical evidence. If not in terms of regressions, so at least displaying the co-variation between the factors and mismatches in regions. For example, one could display a scatterplot between the size of the mismatch in regions, and the demographic structure. I believe that relevant indicators could be calculated for all the dimensions. Such an exercise would make the arguments much more convincing and interesting.

To complement this, we should always keep in mind that the LQs illustrate the spatial variation of a phenomenon (relative), and not how important the phenomenon itself is (absolute). In fact, it would be good to know the absolute level too – how sizeable are the mismatches around European regions? This would be a way to illustrate the absolute importance of the phenomenon. Also, but this is maybe too much of an extension, it would be very interesting to know if the mismatches actually have consequences for regional growth (or, are the mismatches rather a result of growth because growing regions attract labour that maybe cannot be accommodated immediately?). Using the lag structure of the data, such an experiment could be made.

In the policy recommendations, the authors argue for “strong interventions”. However, the interventions that they mention seem to be only vaguely related to the findings of this paper (except maybe for the high-quality career counselling). Instead, I would encourage the authors to develop policy recommendations that are immediately associated with the findings of this paper.

In sum, I find the topic and empirical approach very promising. However, revisions according to the above would give the paper a much stronger basis to argue for particular and precise conclusions concerning the geography of skill mismatches in the European Union. I do hope that the authors find these comments constructive for further work.

Is the work clearly and accurately presented and does it engage with the current literature?
Partly

Is the study design appropriate and is the work technically sound?
Partly

Are sufficient details of methods and analysis provided to allow replication by others?
Not applicable

Are all the source data and materials underlying the results available?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Partly

Are the conclusions drawn adequately supported by the results?
No

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Economic geography

I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

Author Response 08 Apr 2025

Effie Emmanouil

Dear Reviewer, we would like to thank you for your valuable and insightful comments. We have proceeded with major revisions on our manuscript, following most of your points, which we found well raised. These changes have bolstered our arguments, slightly extending the text's wording, without changing its meaning. Please find below our responses to your comments in detail.

1. **The article uses quantitative data to map skill mismatches in selected regions, and discusses reasons as to why these geographical variations arise. In fact, it would benefit the article if it could focus even more on this phenomenon and its explanations. The introduction is interesting because it juxtaposes more traditional human capital theory with arguments derived from geographical political economy. However, while one could debate the outcomes of this intellectual tension, this is not really the core of the article (human capital theory is though dismissed as simplistic and positivist – a language I would myself avoid given the convincing literature on the overall benefits of education and higher skills). The focus of the article is not to estimate the benefits from education. Instead, I would wish for a stronger focus on the geography of skill mismatches in the introduction. This also would open to the real empirical geographical question in the article – what does the geography of skill mismatches look like, and why do differences between regions arise across Europe?**

This is a well raised point. In the revised version of the manuscript, we clarify our empirically-grounded positioning in relation to the HCT. Overall, we try to show that a fruitful synthesis of notions from HCT with notions from GPE can be a very illuminating theoretical and practical exercise that sheds light on the deeper factors driving skill mismatches. Apart from the above, we follow your suggestion and enhance our focus on the uneven geography of skill mismatches. In doing so, we have advanced the aim and the specific questions in the Introduction but also have adapted the subsequent sections accordingly. Especially in the Theoretical and Conceptual Section, we now focus more on the socio-spatial drivers of skill mismatches and explain the reasons why geographical variations arise. This is detailed when addressing your second point. Lastly, in the Introduction we put more emphasis on what the EU is doing to address skill mismatches.

1. **On this topic, there is already a sizeable literature, and this should also not be the core discussion of this paper. While I would actually like to challenge some of the arguments in a within-European context (for example, that growth is a trade-off between regions, the peculiar connection made between vocational training and precarious labour and the new rounds of "Fordist-influenced spatial organization" – within Europe the Fordist era was in fact characterized by decreasing regional economic disparities), this is besides the point. Instead, I**

would like to recommend a stronger focus on the geographies of mismatches and why they arise. The paper would make a stronger contribution if it could remain with this focus. In particular, I would welcome a discussion about the dimensions that the authors later return to as explaining the geography of mismatches: dynamism of national economies, regional specializations, local institutions and demographic structure. In such a context, for example, the discussion about the global production chains and their spatialities is interesting, but it does not quite explain the geography of mismatches.

This is another well raised point that we have taken into account in our revisions. Specifically, the Theoretical and Conceptual Section has been extensively revised so as to follow a clear narrative revolving around the uneven geography of skill mismatches. In this section then, we now present some basic points raised in the literature regarding the factors underlying this uneven geography; to do so, we have added numerous new sources. As you stressed, most of these points pertain to the factors that are inquired in the Discussion Section (dynamism of national economies, regional productive priorities, institutional endowments, urbanization levels, etc.). To deepen this Section's clear targeting, we have also taken out a good part of the postulations regarding the effect of Fordism on uneven development, as well as the role of global value chains. The same principle is followed in the Discussion.

1. **In the empirical part, the use of the different LQs is ingenious. However, it would be great if the authors could comment on the reliability of the mismatch indicator: is there a risk that we simply misjudged the level of skills needed in jobs, or that they changed?**

To clarify the source for our calculated LQs, we now stress in the Methodological Section: *"Data on the matching between highly educated workers and low, medium, and high skill-level occupations are directly calculated by Eurostat, based on its Labour Force Survey."* Further below, we now add in regard to the reliability of the mismatch indicator: *"The classification of skill levels was carried out at our request by Eurostat itself, to eliminate the risk of misjudging skill levels and to increase the reliability of the mismatch index."* It should be clear then, that the shares of highly educated workers per skill-level occupation at the regional level were directly provided to us by Eurostat. Of course, Eurostat's methodology carries some inherent weaknesses, such as that skill mismatches are judged solely based on the correspondence between a worker's education attainment level (following the ISCED typology) and an occupation's demanded skill level (following the ISCO typology). No qualitative dimensions are then taken into account; but this is a shortcoming characterizing most—if not all—secondary analyses on skill mismatches (as noted by several experts in the literature; e.g., see MacGuinness *et al.*, 2018).

1. **And where in the economy do the most important mismatches arise? I believe that this could be easily described using the available data, as an introduction to the geographical analysis.**

We must note that this is another well raised point that would lead to very interesting findings. However, we have not inquired about skill mismatches by sector, for two main reasons. First, for reasons of data limitations. After checking the available data, analysis per sector and region would have to rely on really small samples which would not be reliable. This is stated in the Methodology Section: *"...as the focus of this paper is on the regional level, our analysis cannot include skill mismatches by sector and region, given that this would lead to extensive data fragmentation and therefore to issues of reliability and missing values."* Secondly, a

sectoral analysis would require the addition of substantial text, which would make the manuscript even lengthier. Therefore, we deemed that a sectoral analysis—albeit interesting—lies outside the scope of our paper. Nevertheless, we have included relevant insight from the literature in the Theoretical and Conceptual Section, and then revisit this insight in the Discussion. Specifically, in the former section we write: *"...apart from the dynamism of a regional industrial structure, the sectoral specialization per se plays a key role. Characteristically, sectors like accommodation and catering, commerce and storage, and transportation, are reported to suffer greater skill mismatches—both horizontal and vertical—than others (Chłoń-Domińczak & Żurawski, 2017)."*

1. **It would also be good if the authors explained whether the patterns could be taken to be general – or are the results a feature of the regions/countries that selected themselves into the university initiative?**

Although our study focuses mainly on the ERUA regions and countries, our findings can be considered more broadly. We state the reason for this in the Methodological Section, which is that the countries under study were chosen not only because of the ReERUA Project, but also because they represent all key educational/employment regimes in Europe. Specifically, we write: *"The analysis is conducted at the regional level (NUTS-2) and its geographical scope covers five countries: Greece, Bulgaria, France, Germany, and Denmark. These were chosen on the basis that they represent the main educational/employment regimes in Europe: the universalistic of the Nordic countries, the employment-centered of Continental Europe, the sub-protective of the Mediterranean countries, and the post-socialist of Eastern Europe (Pohl & Walther 2007; Farkas, 2011). While both France and Germany fall under the Continental model, they are both analyzed due to their stark differences in terms of their wage structures (Hein & Vogel, 2009) and educational models (O'Reilly et al., 2019). Given the research's geographical scope covering all main European regimes pertaining to employment and skills, its findings can be contextualized more broadly and provide insight into the EU as a whole."* The above is also implied in the Introduction and the Discussion.

1. **The authors caution a warning for fig. 1.1a and b. It is hard what to make of this – is this part of the analysis reliable or not?**

This is an extremely important point. To address it and secure the reliability of our analysis, we now clarify in the Empirical Analysis Section that: *"Paradoxically, in both Figures 2a and 2b, LQ scores fluctuate exclusively above 1, indicating over-concentrations in all regions for which data were available. The reason for this is because the phenomenon of highly educated workers being employed in low skill-level occupations is inherently limited. As a result, regions with a small number of such workers, which would exhibit LQ scores below 1, have a non-statistically significant sample, thus data for them is missing. Conversely, the available data allows for observing where highly educated workers are over-concentrated in low skill-level occupations."* In other words, our observations regarding where highly educated workers in low skill-level occupations are concentrated, we follow a process of elimination. Namely, although we do not have sufficient data to directly observe which regions exhibit under-concentration of this type of skill mismatch, we systematically exclude all other possibilities based on the available data, and we are left with the answer to our problem.

1. **In the discussion section, the authors are looking for different ways to explain the geographical variation in the mismatches. It would be good to know how the authors ended up thinking about these factors.**

To address this comment, we have revised several sections of our manuscript. In short, we can state here that we ended up with these based on the insight of the relevant literature.

This was the case from the start; however, it is a fact that this was not adequately clarified in our initial submission. Thus, including them in the Theoretical and Conceptual Section was crucial. Doing so, we cover the literature around the role of the dynamism of national economies in skills' geography in a paragraph starting with: *"Various factors shape the widely documented uneven geography of skills and their mismatches (Alamá-Sabater et al., 2024; Cedefop, 2010). Importantly, regional mismatches can be greatly affected by the robustness (or lack thereof) of the broader national economy."* Similarly, we write about the effect of regional specializations: *"At the regional level, the dynamism of an economy is equally crucial. Capital- and technology-intensive activities tend to concentrate in already advanced regions, fueling new rounds of uneven development (Vinuela-Jimenez et al., 2010). As such, metropolitan areas with a diverse economic base concentrate human capital, cutting-edge technology, and finance-related activities, while economically backward and declining regions become even more disconnected from knowledge and innovation (Feldman et al., 2021). Similarly, developed industrial regions tend to attract new activities, workforce, and capital, as they further industrialise (Boudeville, 1968), although in many cases they also spill over positive effects to their surrounding areas (Perroux, 1955)."* The role of institutional endowments is scrutinized throughout this section, as for instance in the part we write: *"Such segmentation is crucially sustained by dual human capital development mechanisms. Namely, next to a robust education system, a training system that focuses more on vocational training and apprenticeship initiatives is formed, serving as a channel for precarious labour (Teixeira, 2019)."* Apart from the above, we lay out the relevant literature's insight into the effect of crises of various types on the geography of skill mismatches in the paragraph starting with: *"Beyond the national and regional factors, sudden shocks of economic or other nature, as well as structural transitions, directly contribute to increasing skill mismatches (Cedefop, 2015)."* The latter is particularly important in justifying our rationale behind the temporal scope of our paper covering a period of successive crises. Then, in the Empirical Analysis these crucial factors are scrutinized through a series of correlations between our LQs and proxies. Relatedly, we state in the Methodological Section: *"Regarding the correlation analysis, the research at hand statistically associates the LQ values of the above analysis with crucial factors underlying the geographical allocation of skills as noted in the relevant literature (e.g. Cedefop, 2010). Specifically, it links the LQL, LQM, and LQH with regional and national GDP (both total and per capita), the European Commission's Regional Innovation Index, urbanization levels, the Ageing Index, and the Dependency Index (see Table 1)."* Further below, in the beginning of Discussion, we stress this again: *"Drawing upon our main findings, here we discuss the most crucial factors underlying the uneven geography of skill mismatches. In this framework, we put particular emphasis on the economic dynamism of national economies, regional industrial structures, urbanization, local institutional structures and practices, and demographic structures, drawing from the main findings of the relevant literature (Alamá-Sabater, 2024; Cedefop, 2010)."*

1. **Secondly, it is a bit hard for the reader to evaluate the relevance of the factors. Here, I would recommend the authors to provide empirical evidence. If not in terms of regressions, so at least displaying the co-variation between the factors and mismatches in regions. For example, one could display a scatterplot between the size of the mismatch in regions, and the demographic structure. I believe that relevant indicators could be calculated for all the dimensions. Such an exercise would make the arguments much more convincing and interesting.**

To address this crucial comment, which was among the most important we received, we proceeded with major revisions on our manuscript. Specifically, following your suggestions,

we added a correlation analysis (through Pearson's R) to our implemented methodologies. Specifically, bivariate correlations have been conducted between the LQ_L, the LQ_M, and the LQ_H on the one hand, and the national and regional GDP (total and per capita), a regional Innovation Index by the European Commission, population density representing the level of a region's urbanisation, as well as the Ageing Index and the (labour force) Dependency Index pertaining to a region's demographic structures. The specifics of this analysis (temporal scope, methods, data sources, interpretation approach, etc.) are laid out in detail in the last paragraph of the Methodological Section. Then, in the Empirical Analysis section, the correlation analysis follows the existing LQ analysis so as to contextualize its findings. The results of the correlation analysis are presented in detail in a correlation matrix (Table 1). We believe that with the above we make our arguments in the Discussion more convincing, since they are now clearly evidence-based.

1. **To complement this, we should always keep in mind that the LQs illustrate the spatial variation of a phenomenon (relative), and not how important the phenomenon itself is (absolute). In fact, it would be good to know the absolute level too – how sizeable are the mismatches around European regions? This would be a way to illustrate the absolute importance of the phenomenon.**

Please note that apart from the LQs that are presented in Figures 2-4, we also include a table in the Annex that displays all raw data based on which we calculated the LQs. Specifically, in this table we lay out the shares of highly educated workers per skill-level occupation within each region under study. This way, the reader has a clear view of the magnitude of the phenomenon under study. We also considered including the absolute volumes of the above, however, that would make the table much bigger, which we decided to avoid.

1. **Also, but this is maybe too much of an extension, it would be very interesting to know if the mismatches actually have consequences for regional growth (or, are the mismatches rather a result of growth because growing regions attract labour that maybe cannot be accommodated immediately?).**

To address this comment, we have included in our correlation analysis the regional GDP. Based on the findings of this analysis, we draw a series of findings on the link between skill mismatches and regional growth. Specifically, regarding LQH, we note in the Empirical Analysis Section: *"The above findings indicate that perfect skill matching can mainly be observed in regions with robust economies, regardless if they are located in countries that are not as economically dynamic."* Further below, we write about LQM: *"…it is found that productive robustness at the national level affected this type of skill mismatch more than robustness at the regional level did."* Lastly, regarding LQL, we write: *"…there are many regions within otherwise robust national economies that exhibited extreme overskilling, as well as regions within meagre national economies with optimal skill matches."*

1. **In the policy recommendations, the authors argue for "strong interventions". However, the interventions that they mention seem to be only vaguely related to the findings of this paper (except maybe for the high-quality career counselling). Instead, I would encourage the authors to develop policy recommendations that are immediately associated with the findings of this paper.**

In the revised version of the text, we toned down the statement about "strong interventions", writing instead that: *"To break this pattern of uneven development, policy interventions are required."* Nevertheless, in the revised Conclusions policy recommendations

are more targeted and concrete, drawing directly from the findings of the Empirical Analysis. Specifically, they revolve around the significance of: knowledge spillover and alignment between education and innovation needs; entrepreneurial activity rechanneling into underdeveloped regions; and lagging regions' re-specialization in more dynamic high value-added and high-skill sectors. For each one of those, we provide specific examples and/or cases.

Competing Interests: No competing interests were disclosed.