1972
2022
wiiw

NOVEMBER 2023

Working Paper 235

A Comparative Analysis of the Social Situation Between Carbon-intensive and Noncarbon-intensive Regions

Larysa Tamilina and Roman Römisch

The Vienna Institute for International Economic Studies
Wiener Institut für Internationale Wirtschaftsvergleiche

A Comparative Analysis of the Social Situation Between Carbon-intensive and Noncarbon-intensive Regions

LARYSA TAMILINA
ROMAN RÖMISCH

Larysa Tamilina is Associate Professor at the Kyiv School of Economics and Research Associate at The Vienna Institute for International Economic Studies (wiiw). Roman Römisch is Economist at wiiw.

Research for this working paper was implemented within the framework of the project Carbon Intensive Regions in Transition (CINTRAN), funded by the European Commission Innovation and Networks Executive Agency (Project No. 884539).

Support provided by the European Commission Innovation and Networks Executive Agency for this research is gratefully acknowledged.

Abstract

This study focuses on the social situation in carbon-intensive regions and the role of migration in defining its quality. The analysis examines whether carbon-intensive areas, especially those with large outward migration, are more vulnerable to adverse social trends than other regions. Our findings reveal a robust association between the processes of decarbonisation and migration, which collectively exert a significant impact on the social conditions within EU regions. This influence is assessed using various indicators, such as the Social Progress Index, employment rates, availability of hospital beds, access to preschool education, and the prevalence of severe material deprivation. We demonstrate that compared to noncarbon-intensive regions, carbon-intensive regions, compelled as they are to undergo structural changes to meet environmental requirements, have a diminished capacity to offer their residents satisfactory employment opportunities and a high quality of social life. Moreover, if carbon-intensive regions experience the challenge of negative net migration, their social development is highly likely to face a notable deterioration. On the other hand, in cases where inward migration predominates, regions at risk of decarbonisation tend to exhibit minor deterioration – and even outperform the noncarbon-intensive group experiencing outward migration.

Keywords: decarbonisation, migration, social situation, EU-SPI, EU regions

JEL classification: Q01, R23, I31

CONTENTS

TABLES AND FIGURES

1. Introduction

Ever since the creation of the European Union, there has been a strong commitment to the idea of a social market economy (Annoni and Bolsi, 2020). The combination of rapid and sustainable economic development, coupled with a suitable standard of living for everyone, regardless of age, gender or migration origin, was expected to provide an effective framework for social cohesion in Europe. To this end, employment policies and social provisions supplemented the market mechanisms to ensure the achievement of social objectives in member states.

A necessary precondition for this was the formulation of social rights that guarantee fair access and equal opportunities in the EU. In pursuit of this goal, in 2017 the European Parliament, the Council and the Commission announced the creation of the European Pillar of Social Rights (European Commission, 2017). Emphasising the social dimension in Europe, the pillar defined 20 principles that laid the foundation for fair and well-functioning labour markets and welfare systems in the EU. The principles focused on creating mechanisms that guarantee equal access and opportunities in three main domains: labour markets, working conditions, and adequate and sustainable social protection.

Accordingly, the labour market mechanism assumed the provision of equal access to employment and lifelong-learning opportunities that focus on the creation of new skills that facilitate integration into employment or transition from one job to another (European Commission, 2021a). Fair working conditions secured the labour-force structure, safety and equality of pay for various risk groups. Lastly, the pillar envisaged equality of access to and opportunities for receiving social protection in the case of contingencies. Through these principles, the achievement of social cohesion in the EU was regarded as possible.

However, the vision of equality of social rights can be sorely tested as Europe struggles to switch to a climate-neutral economy. For the EU member states to meet the environmental requirements of the Paris Agreement will require the rapid phasing-out of fossil fuel consumption in the power sector and the decarbonisation of fossil fuel-dependent industries. The transition will involve profound structural change that could have a broad socio-economic and environmental impact, starting with carbon-intensive regions. This implies that regions which are economically dependent on fossil fuel extraction or energy-intensive industries will be disproportionately affected by the shift to an environment-neutral economy (European Commission, 2021b).

Consequently, the social rights of those in the affected areas will be severely challenged. Closing down or restructuring carbon-intensive industries will induce job losses and a significant need to reskill and upskill workers in industrial sectors. This will restrict people’s access to employment, as well as the availability and quality of learning and training services. In the face of shrinking employment opportunities, the issue of fair working conditions could acquire a secondary significance that may limit individuals’ social rights in this domain. As well as having repercussions for jobs, the structural change could also have an impact on incomes and their distribution, which would primarily affect vulnerable groups. The resulting increase in poverty and social exclusion will pose a severe risk to community cohesion, leading to regional disparities in the EU's social dimension.

To ensure a fair transition, the EU has established the Just Transition Fund (JTF) to support implementation of the cohesion policy (European Commission, 2021b). By providing multiannual financial support to vulnerable regions, the JTF aims to eliminate disproportionality in the capacity of those regions to cope with the transition toward a climate-neutral economy. Linked to the European Pillar of Social Rights, the JTF is expected to promote social inclusion in the affected areas by funding new job creation, reskilling and training the affected workers, as well as expanding the social infrastructure for child and elderly care.

Despite the wide range of measures adopted by the EU to protect the social rights of people in carbon-intensive regions, there remains a lack of clear understanding of how the structural change induced by the decarbonisation process will affect their social situation. In particular, the role of migration in this process has only been marginally considered. Concurrently, theoretical and empirical studies emphasise that outward migration is expected to play a key role in meeting environmental requirements, by becoming a key adaptation mechanism in carbon-intensive areas (OECD, 2012). Researchers admit that the decline of specific sectors will make the affected regions less attractive places in which to live and work (Biagi and Dotzel, 2018). As a consequence, those regions are likely to experience intense outward migration, which could have an adverse effect on equality of access to and opportunities for social rights for their citizens.

More specifically, outward migration could substantially change the population structure, leading to cumulative negative processes in terms of social demography (Wirth et al., 2012). Given that those who leave are the most vital population groups (OECD, 2012), outward migration could affect human capital accumulation in the regions concerned by reducing the share of the medium- and high-skilled working-age population (Sayegh, 2017). Adverse demographic developments may hence create an obstacle to effective restructuring of the regional economy – since that process would require a skilled workforce (Özgen et al., 2011).

As well as changing the population structure, the outward migration of medium- and high-income groups may also weaken demand for goods and services in the locally oriented economy, thus reducing its competitiveness. Consequently, the remaining population may lack equal opportunities at a time of transition, often due to the declining quantity and quality of the economic and social infrastructure (Rodríguez-Pose, 2018). A worsening social situation would be likely to create a downward spiral of further loss of services, deterioration in infrastructure and housing, loss of amenities and a negative image of territories. Economic decay and limited options in the affected areas could ultimately result in socio-spatial segregation (OECD, 2012).

This study focuses on analysing the social situation in carbon-intensive regions and the role of migration in defining their dynamics. More specifically, it aims to examine whether carbon-intensive areas – especially those with large outward migration – are more vulnerable to adverse social trends than other regions. In doing so, we apply a comparative perspective, juxtaposing the social situation in the two types of region. Both these groups are believed to face unique migration challenges: noncarbon-intensive regions primarily have migration resulting from the right to free movement within or across EU countries, while carbon-intensive areas are characterised by migration prompted by structural changes that cause mass job loss and skills mismatch. Considering the differences in the underlying reasons for emigration from the two regional groups, it is expected that outward migration should affect carbon-intensive and noncarbon-intensive regions differently.

The concept of the heterogeneous effects of migration is not new in the literature: there has been abundant research into heterogeneity in migration impacts or consequences. For instance, outward migration has been found to be either a positive or a negative development factor, depending on the economic and social conditions in which it occurs. In the context of economic downturns and high unemployment, out-migration is usually economically beneficial (Kahanec and Zimmermann, 2009). In aging, low-fertility societies, it becomes a relatively consequential driver of negative change, including population decline (Potančoková et al., 2021).

Thus, we hypothesise a wide variation in the amount of outward migration across carbon-intensive and noncarbon-intensive regions, and heterogeneity in the impact it has on their social development. The main research question we seek to answer is whether carbon-intensive areas – particularly those subject to large out-migration – perform worse than economically similar noncarbon-intensive regions in terms of their social situation.

2. A comparative analysis of migration trends between carbon-intensive and noncarbon-intensive regions

The technological transformation and structural change aimed at meeting the environmental requirements of the Paris Agreement have brought the issue of outward migration to the forefront of discussion in the EU (Potančoková et al., 2017). The fundamental premise is that EU regions will face a different scale of restructuring in response to the shift to a climate-neutral economy. Consequently, these regions may have varying rates of emigration and immigration flows. To understand how the two phenomena are linked, we examine the variation in net migration rates between carbon-intensive and noncarbon-intensive regions. Our main objective is to juxtapose the key features behind migration between the two types of region, depending on their degree of involvement in the decarbonisation process.

We defined the list of carbon-intensive areas based on their level of energy and technological risks, as determined by E3 Modelling (https://e3modelling.com/), one of the leading carbon/environmental research institutes in Europe. In total, 21 regions at the NUTS2 level were defined as carbon intensive,[1] and the remaining regions were combined into a single group of noncarbon-intensive units of analysis. Given that these regions constitute a primary interest for the CINTRAN project, we called this sample the CINTRAN selection.

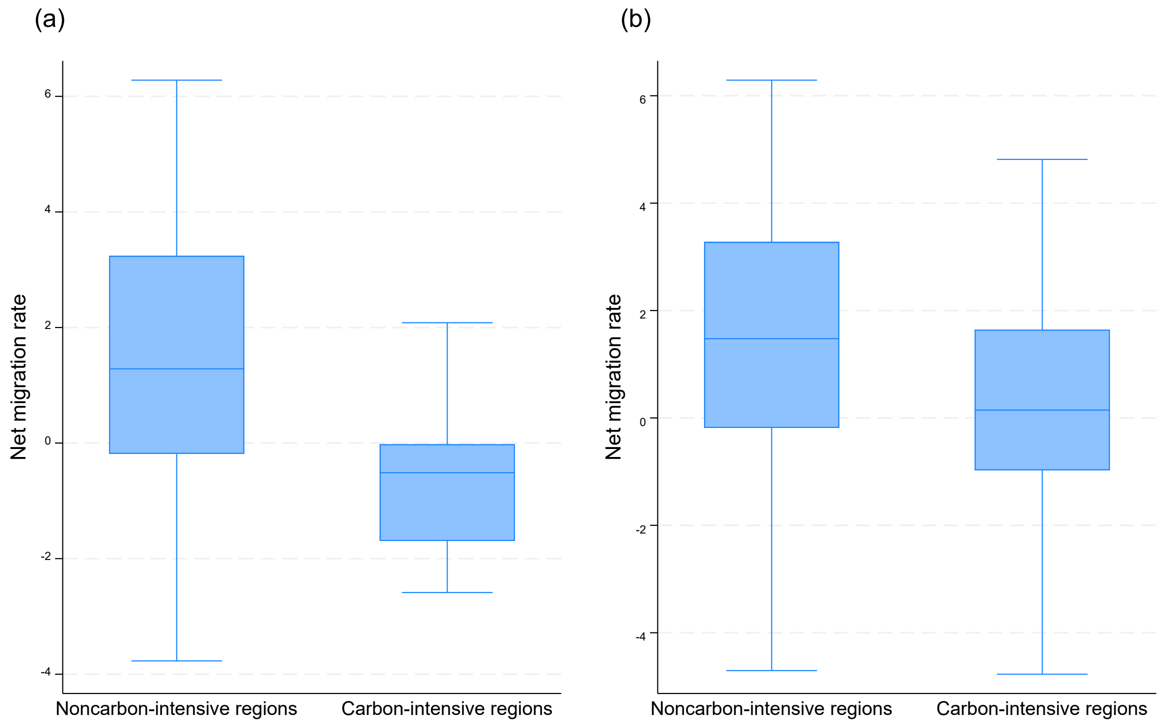
In addition to E3 Modelling, we used the list of regions determined by the Just Transition Fund (JTF) as affected by the process of meeting environmental requirements and marked as eligible for funding. The selection includes 52 regions at the NUTS2 level, which is larger than the E3 Modelling selection. However, there was a significant overlap between the two samples, in which the JTF group of NUTS2 areas comprised the majority of regions from E3 Modelling. We defined this sample as the JTF selection. Both regional classifications were used in the analysis and were expected to complement each other by enabling a test of the sensitivity of our findings.

For our analysis, net migration rates were retrieved from the Eurostat website and represented the crude rate of population change through migration, calculated as the difference between inward and outward migration flows. Overall, our sample included 239 NUTS2 regions in 27 EU countries and demonstrated a significant variation in the net migration rates between the two regional groups. Outward migration was a less likely outcome in regular areas, while carbon-intensive regions could more often end up with net outmigration. In particular, 74.4% of the CINTRAN carbon-intensive regions were characterised by net emigration. In contrast, only 27.5% of the CINTRAN noncarbon-intensive regions faced emigration. Similarly, a negative net migration rate was established for 45.1% of the areas defined as carbon-intensive by the JTF, whereas this reached merely 27.7% for the noncarbon-intensive group.

[1] The group of carbon-intensive regions includes the following NUTS2 regions: BE21, BG34, CZ04, CZ08, DEA3, EE00, EL53, EL64, EL65, ES12, ES42, HR03, HU31, PL22, PL71, PL81, RO22, RO31, RO41, RO42, SK02.

Figure 1 compares the median migration rates and their variability between carbon-intensive and noncarbon-intensive areas. Briefly, the box plots suggest that regions belonging to a noncarbon-intensive group have a positive median and demonstrate more significant variability within the group. By contrast, the affected regions perform worse on migration and are often characterised by a prevalence of emigration. Carbon-intensive areas are more likely to experience a significant outflow of people than are areas outside the risk group.

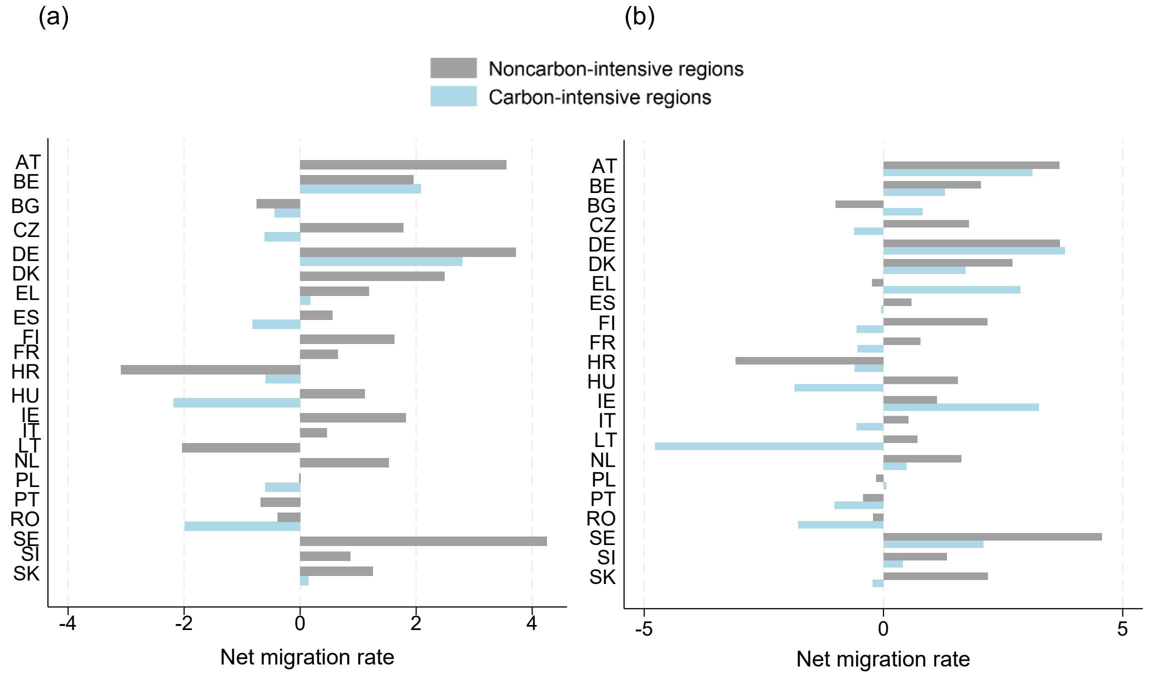
Figure 1 / Box plots of net migration rates in 2020, categorised by region type ((a) the CINTRAN selection and (b) the JTF selection)



Note: (a) refers to the net migration rates for the region type based on the CINTRAN selection, while (b) illustrates the net migration rates based on the JTF selection.
Source: Eurostat.

However, the difference in migration outcomes between the two types of region is, to a large extent, a country-specific phenomenon that varies widely across EU member states. Figure 2 compares the net migration rates between carbon-intensive and noncarbon-intensive regions for each country separately. Generally, both graphs show that noncarbon-intensive areas outperform carbon-intensive ones in their migration flows. Countries with both regional groups tend to have strictly positive or more positive net migration rates for their ‘risk-free’ areas. By contrast, carbon-intensive regions are characterised by either outward migration or significantly lower levels of prevailing immigration.

Figure 2 / A comparison of mean values for net migration rates in 2020 between carbon-intensive and noncarbon-intensive regions, by country ((a) the CINTRAN selection and (b) the JTF selection)



Note: (a) refers to countries' mean net migration rates calculated for the two region types based on the CINTRAN selection, while (b) illustrates countries' mean net migration rates calculated for the two region types based on the JTF selection. Mean values were produced based on the NUTS2 regional data.
Source: Eurostat.

At the same time, the ultimate migration outcome appears to show some association with the overall economic development of countries of interest. Those of the EU's older member states with a high level of economic progress possess a minor cleavage in their net migration rate between the two types of region (e.g. Germany, Belgium and Austria). Conversely, less economically developed EU economies, such as Southern European countries or former Soviet republics, tend to demonstrate a more significant difference in migration outcomes. Surprisingly, some even show a reverse relationship between decarbonisation and migration, in which prevailing outward migration is a more common phenomenon for noncarbon-intensive than for carbon-intensive areas.

Note that in certain EU countries, the NUTS2 region corresponds to the entire country, In the case of Estonia, Cyprus, Latvia, Luxembourg and Malta, the NUTS2 regions encompass the entire national territory, meaning there is no subdivision into smaller regional units. The inability to separate coal regions from the rest of the country in these member states can lead to distortions in data analysis. In particular, when studying migration patterns or socio-economic indicators, it becomes challenging to attribute specific outcomes solely to decarbonisation and isolate them from broader national dynamics. As a result, this lack of distinction can mask the unique challenges and opportunities associated with coal regions and may affect the accuracy of our calculations. To avoid this, we omitted these five countries from our data in any further investigation.

Overall, it can be concluded that the range of problems that may be created by trying to meet the environmental requirements includes, among others, the problem of intense outward migration. The latter trend will likely produce an additional load on the affected regions by causing negative socio-demographic developments and by damaging the overall economic and social situation in the entire area. Therefore, an analysis of the effects that the decarbonisation process may entail should be coupled with the issue of migration, especially if this migration takes the form of a major outflow of people from the regions.

Drawing on this link between decarbonisation and migration, we introduce a new comprehensive classification of regions, as depicted in Figure 3. The typology is made along two dimensions. The first captures the region's involvement in the decarbonisation process and includes the division between carbon-intensive and noncarbon-intensive areas. The second focuses on the type of migration that prevails in a region, by distinguishing between net inward and net outward migration. Plotting the two dimensions against one another produces four regional groups: (1) carbon-intensive with net outward migration; (2) carbon-intensive with net inward migration; (3) noncarbon-intensive with net outward migration; and (4) noncarbon-intensive with net inward migration.

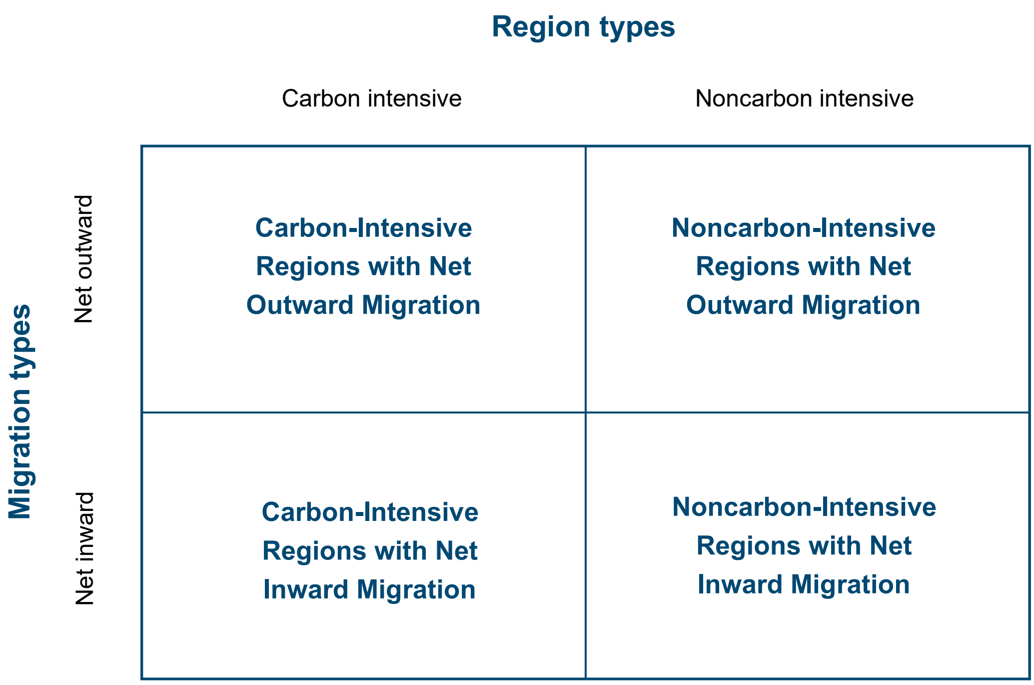
We argue that this typology could serve as a valuable instrument in comprehending the social dynamics within each region type. Our fundamental premise is that both the process of decarbonisation and the occurrence of outward migration are intrinsically linked to specific socio-demographic and economic challenges. Consequently, the nature of social problems in the region should be determined by the presence or absence of both challenges or by the specific challenge encountered. In particular, the coexistence of decarbonization efforts and outward migration simultaneously brings about a combination of socio-demographic and economic challenges, resulting in a distinctive set of social problems. When only one of the challenges (decarbonisation or outward migration) is experienced, it defines a distinct array of socio-demographic and economic issues, thereby influencing the social situations differently. This suggests that knowing where the region belongs with respect to decarbonisation and net migration trends can effectively reveal the kinds of problems that the region will encounter and how it will score on the overall social situation.

More specifically, the carbon-intensive group with outward migration will encompass regions that face a double challenge that includes both decarbonisation and population shrinkage due to emigration. The latter is expected not only to influence the size of the population, but also to impact the population structure, since those who leave are likely to be younger (Zimmermann, 2005). Changes in the population's age structure will reduce fertility rates and increase life expectancy, which will have repercussions for welfare systems (Greenwood, 1997). The increased share of older people will boost demand for health and long-term care, making this age group a primary policy target that will absorb most of the available funding. In parallel, structural change will also demand resources for the technological shift, which will further restrict the funds available for tackling social problems at the regional level. As such, we expect this group of regions to be characterised by the worst social situation and a significant limitation to the social rights provided to their residents.

By contrast, the carbon-intensive group with inward migration primarily faces the objective of decarbonisation through technological restructuring of its energy industries or energy-intensive industrial sectors. Inward migration will support structural change, allowing regions to focus on meeting environmental requirements. These regions will not encounter the problem of the population shrinking or a severe change to their population structure. Consequently, they will not have to divert resources from technological shifts to tackling the social problems that both negative socio-demographic developments may bring about. We expect this group to be more successful at promoting the technological transition to a climate-neutral economy, while continuing to effectively support the provision of adequate social rights to their populations. The growing population size is likely to increase demand for social goods and services, leading to a robust social infrastructure in the area that meets the needs of the entire population.

Conversely, noncarbon-intensive regions with net outward migration are expected to experience primarily negative socio-demographic developments caused by an increased population outflow. Like their carbon-intensive counterparts, they will experience an adverse change in population size and structure that will require many resources to support an adequate quality of life for everyone. As social rights and the quality of social situations are directly linked to socio-demographic developments, we expect this regional group to perform poorly on most social indicators. However, the relative lack of any need to meet environmental requirements and introduce structural change will free up resources to eliminate the consequences of outward migration, at least partially. This suggests that noncarbon-intensive regions should perform better than carbon-intensive ones when negative migration rates prevail.

Figure 3 / Typology of regions based on decarbonisation and net migration rates



Source: Authors' illustration.

Lastly, the noncarbon-intensive group with net inward migration should outperform other regions. Such areas do not require any structural change and will experience no adverse socio-demographic developments that could affect their social situation. Regions belonging to this group may be said to constitute an ideal type and should have above-average scores on any social indicator measuring the quality of social infrastructure or social rights available to their residents.

The regions' positioning in the two-dimensional space allows us to formulate initial expectations regarding the quality of their social situation or social rights. In summary, we anticipate that:

Hypothesis 1: The noncarbon-intensive group with inward migration should outperform all other groups on social indicators.

Hypothesis 2: Carbon-intensive regions with inward migration should have a relatively good social situation, since they are unlikely to face severe adverse socio-demographic developments.

Hypothesis 3: Noncarbon-intensive regions with outward migration will encounter multiple socio-demographic problems, due to changes in their population size and structure; these will inevitably have many negative consequences for their social conditions.

Hypothesis 4: Regions that face the double challenge of decarbonisation and negative net migration rates will be associated with the lowest social scores, reflecting their worsening social situation and the limited social rights provided to their residents.

Hypothesis 5: The ultimate impact on social indicators of decarbonisation and outward migration – whether singly or in combination – is expected to be contingent upon the overall economic and social advances within the respective country.

3. Data and methods description

As our main dependent variable, we used the EU Social Progress Index (EU-SPI) (Annoni and Bolsi, 2020) from the year 2020, provided by Eurostat. The index measures social progress in European regions at the NUTS2 level, using 55 comparable social and environmental indicators, and deliberately excluding economic aspects. These components were aggregated into three broader dimensions that describe basic human needs, foundations of well-being and opportunities. The basic dimension unites the components that are necessary – though not sufficient – to achieve favourable levels of social development, such as the quality of nutrition and basic care, water and sanitation, housing, and personal security. The foundation of well-being dimension measures more advanced factors of social and environmental progress, such as access to basic education, internet connection, health infrastructure and environmental quality. The opportunity dimension comprises the 'most advanced' components of a cohesive and tolerant society by measuring the quality of access to tertiary education, personal rights, freedom, tolerance and cohesion in society.

In addition to the EU-SPI and its three sub-indexes, we selected four distinct social indicators from 2019: employment rates; access to early education; the availability of hospital beds; and severe material deprivation. Only the availability of hospital beds was taken for the year 2018. Employment rates were used to measure the quality of social rights in the labour market. The percentage of children in early (preschool) education reflected the opportunity to avoid educational inequality. The number of beds per 100 000 inhabitants was used to approximate the quality of health care. Finally, the extreme material deprivation index represented the percentage of people experiencing severe poverty – a proxy for the quality of the social security system. The Eurostat regional statistics were used as the main source for operationalising these four social indicators.

For our primary method of analysis, we employed a multilevel model to account for the hierarchical structure of the data (Kreft and de Leeuw, 1998; Snijders and Bosker, 1999). This approach was chosen in order to address the nested nature of regions within countries. By incorporating both regional and country levels simultaneously, we prevented the aggregation of unaccounted information into a single error term. This allowed us to examine the deviation of observations within each cluster (country), as well as the deviation of each cluster from the overall sample mean. Owing to this, our multilevel models enabled a more comprehensive understanding of the relationships and variations within and between countries, enhancing the validity and robustness of our analysis.

We initiated the analysis by employing a random intercept model, wherein the intercept term was permitted to vary across clusters, specifically countries. This approach involved the introduction of a random variable for the intercept term, resulting in the equation taking the following form:

$$\gamma_{ij} = \beta_{0j} + \beta_1 x_{ij} + \epsilon_{ij}$$

where γ_{ij} represents the outcome variable for observation, i is within cluster j, β_{0j} denotes the varying intercept for cluster (country) j, x_{ij} represents the independent variable for observation i within cluster j, β_1 represents the fixed effect coefficient, and ϵ_{ij} denotes the error term at the regional level.

By allowing the intercept term to vary across clusters, we captured the inherent differences between countries and accounted for the variations in the intercept values within each country. This modelling approach enabled a more nuanced analysis of the data, considering the heterogeneity among countries, while examining the relationship between the independent variables and the outcome variable. Applied to our analysis, the base model to be estimated is:

$$Social\_situation_{ij} = \beta_{0i} + \beta_1 Region\_type_{ij} + \beta_2 Welfare\_state\_type_{ij} + \beta_3 GDP\_per\_capita_{ij} + \beta_4 Roads\_accessibility_{ij} + \beta_5 Population\_size_{ij} + e_{ij},$$

where *Social_situation* is a key dependent variable, operationalised through the selected social indicators measuring the quality of the social situation in the EU regions. The list includes the overall EU-SPI score, the three EU-SPI sub-indexes and the four individual social measures of employment rate, percentage of children in early education, hospital bed availability and the severe material deprivation rate. *Region_type* is the main independent variable, which consists of four binary variables describing the division of regions into the four groups, as presented in the typology.

In addition, we incorporated several covariates into our analysis to account for various factors that may influence the observed outcomes within the regions. These covariates included welfare state types, levels of economic development, accessibility of regions via road networks, and population size. To capture the welfare state types, we employed a categorical variable *Welfare_state_type* comprising five binary indicators that represented Esping-Andersen's welfare state regimes: Social Democratic, Conservative, Southern European, Liberal and a group encompassing the post-communist economies. To control for the levels of economic development, we calculated *GDP_per_capita* by dividing the GDP of the regions (measured in tens of thousands) by their respective population sizes. Eurostat regional statistics served as the data source for obtaining both GDP and population measures. The accessibility of regions was measured using the *Roads_accessibility* index, which offers an overview of overall transport performance and accessibility within the regions. This index was computed by calculating the ratio of the population that has access within an hour and a half by road to the population residing within a 120 km radius of the region, multiplied by 100.

Population_size was incorporated as a covariate to approximate the relative size of the regions. It was operationalised by considering the number of individuals (measured in tens of thousands) residing in each NUTS2 area.

Subsequently, we employed a random intercept and coefficient model to estimate the relationship between the region type variable and the outcome variable, allowing the slope of the region type variables to vary across countries. This modelling approach acknowledged that the influence on society of belonging to a carbon-intensive or a noncarbon-intensive region may differ from country to country. Each country was assigned unique intercepts and coefficients on the independent variable, accounting for the potential heterogeneity in the effect of region type on the outcome variable across countries.

The equation to be estimated can be represented as follows:

$$
\begin{aligned}
Social\_situation_{ij} &= \beta_{0i} + \beta_1 Region\_type_{ij} + u_{1j} Region\_type_{ij} + \beta_2 Welfare\_state\_type_{ij} \\
&+ \beta_3 GDP\_per\_capita_{ij} + \beta_4 Roads\_accessibility_{ij} + \beta_5 Population\_size_{ij} + e_{ij},
\end{aligned}
$$

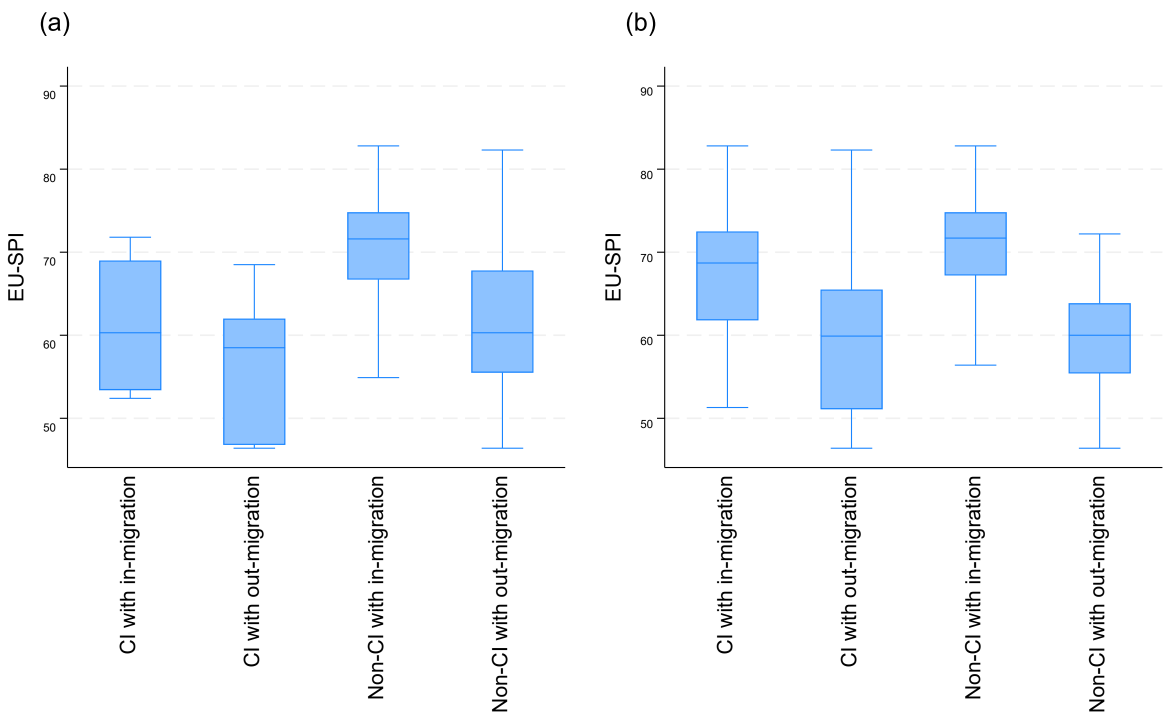
where, u_{1j} is a random variable for the slope.

Lastly, we estimated interactions between the four types of region and the key control variables. The objective of this interaction analysis was to elucidate the primary regional or country-specific characteristics that either mitigate or amplify the detrimental effects associated with belonging to the carbon-intensive group, particularly characterised by outward migration.

4. A descriptive analysis of the social situation in the four types of region

In this section, our main interest lies in checking whether carbon-intensive regions, especially those with outward migration, are at risk of deteriorating social conditions. Figure 4 below focuses on the overall EU-SPI values and shows that social progress varies across regional groups in a particular manner, which can be summarised in three main points. First, noncarbon-intensive regions with inward migration outperformed all other groups on the EU-SPI. Second, the sharpest decline in the quality of social progress was observed in carbon-intensive areas with outward migration. Third, noncarbon-intensive regions can outperform carbon-intensive ones only if they have inward migration: as soon as their net migration rates turn negative, their EU-SPI scores drop below the level observed in the carbon-intensive group with inward migration. The above conclusions are valid for both the CINTRAN and JTF selections.

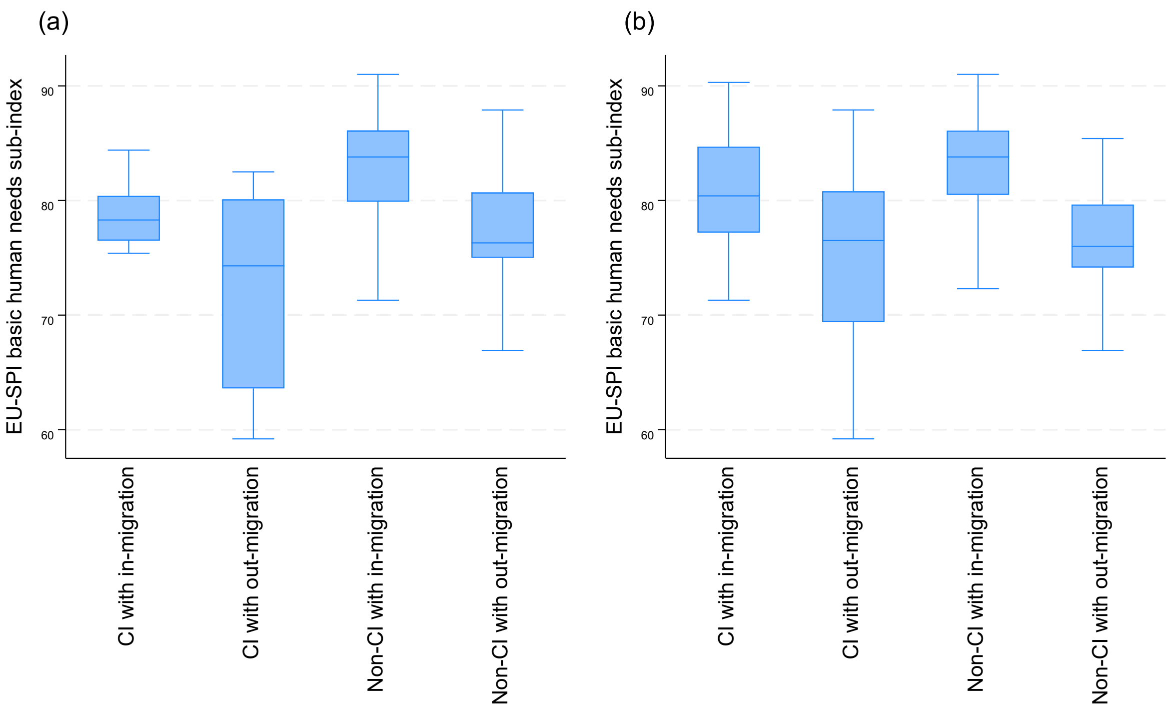
Figure 4 / Variation in the EU Social Progress Index by regional group ((a) the CINTRAN selection and (b) the JTF selection)



Source: European Commission: EU regional and urban development (https://ec.europa.eu/regional_policy/information-sources/maps/social-progress_en).

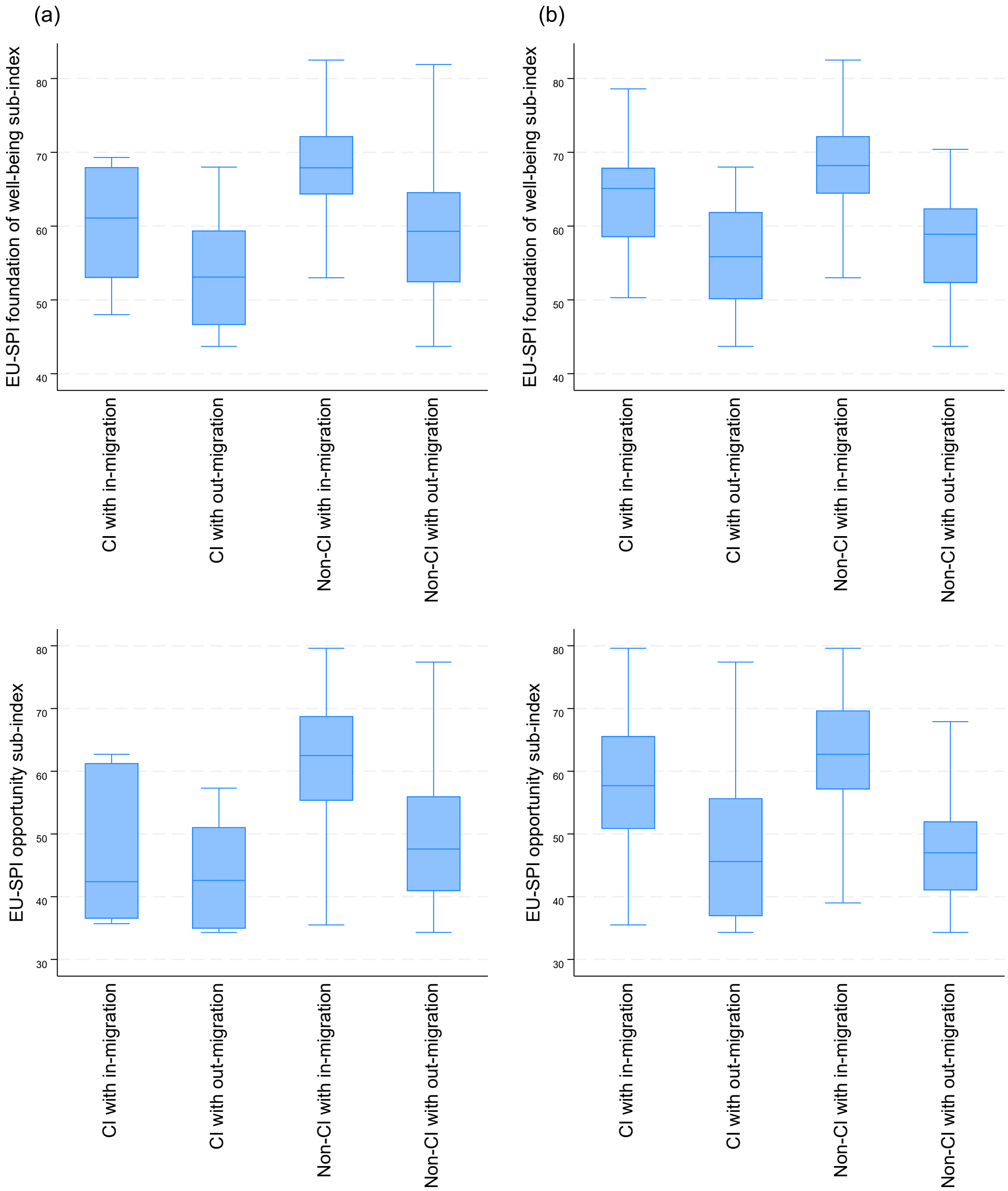
Figure 5 below demonstrates that each of the EU-SPI dimensions follows a pattern similar to that found for the overall EU Social Progress Index. As shown before, noncarbon-intensive regions outperform carbon-intensive ones only if they have net positive migration. Regions with net negative migration perform worse, particularly if they belong to the carbon-intensive group. The only difference from previous findings is a noticeable variation in the median values across the three sub-indexes. All four groups have relatively higher scores on the EU-SPI basic dimension of human needs, with between-group differences remaining relatively limited. When moving to the EU-SPI foundation of well-being component, the situation changes drastically: lower scores characterise all four region types, while between-group variation increases. This phenomenon becomes even more apparent if the comparison focuses on the EU-SPI opportunity dimension. This finding suggests that it is relatively easier to provide basic human needs to regional residents than it is to ensure equal access and opportunities in more complex areas of social life, such as well-being, personal rights or cohesion, as captured by the EU-SPI dimensions of higher order.

Figure 5 / Variation in the EU Social Progress sub-indexes by regional group ((a) the CINTRAN selection and (b) the JTF selection)



Contd.

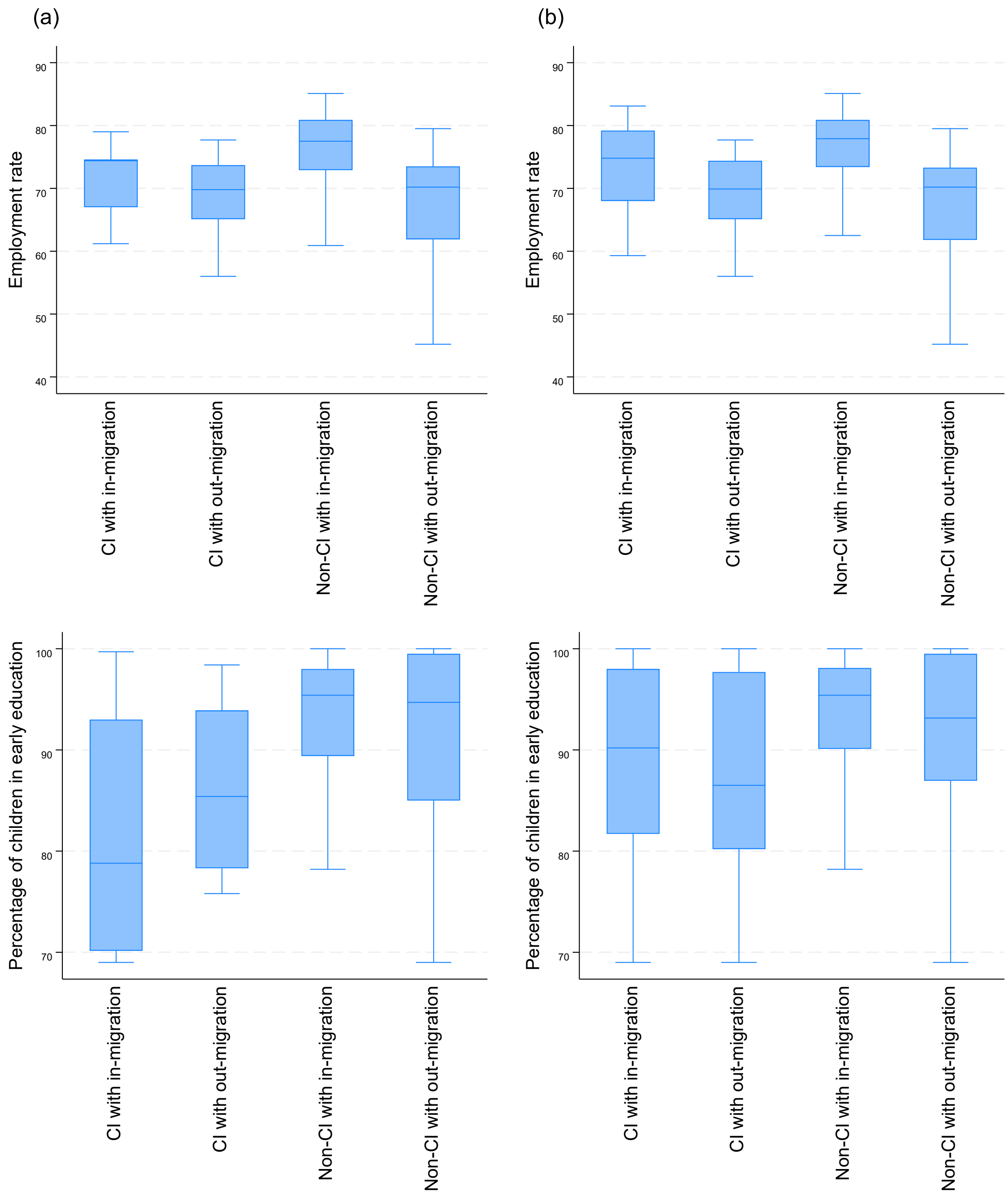
Figure 5 / Continued



Source: European Commission: EU regional and urban development (https://ec.europa.eu/regional_policy/information-sources/maps/social-progress_en).

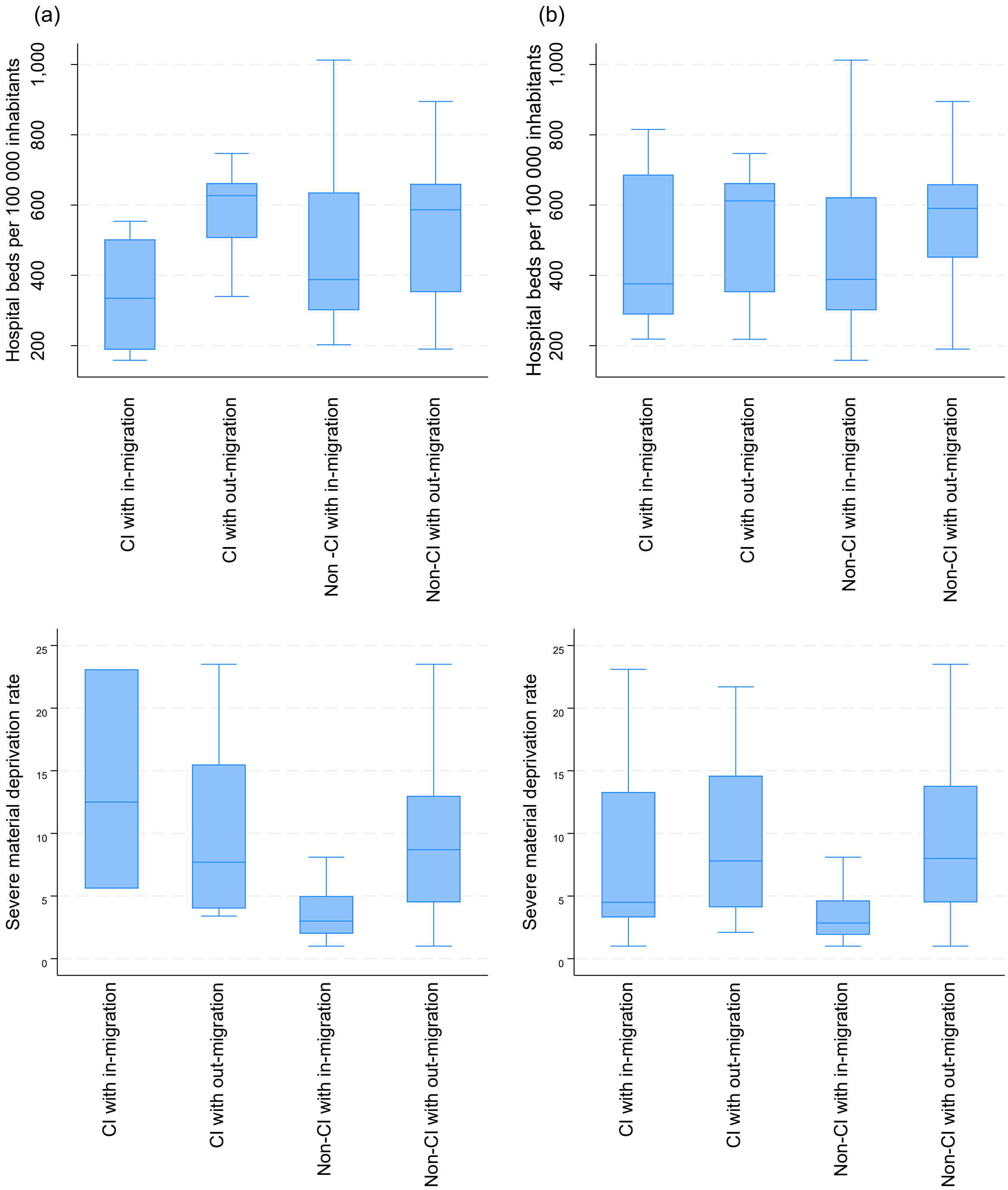
Similarly, Figure 6 presents box plots for the four individual social indicators. Despite the wide variation in employment rates across the four regional groups, the employment levels can be seen to increase as soon as the same type of migration characterises them. More specifically, regions with inward migration create better labour market prospects for their residents than those with outward migration, regardless of the extent of their involvement in the shift to a climate-neutral economy. In the case of employment, it is not energy risk that defines individuals' opportunities in the labour market; rather, it is the change in population size (and presumably population structure) due to migration that influences the ability of regions to cover the employment needs of their residents.

Figure 6 / Variation in individual social indicators by regional group ((a) the CINTRAN selection and (b) the JTF selection)



Contd.

Figure 6 / Continued



Source: European Commission: EU regional and urban development (https://ec.europa.eu/regional_policy/information-sources/maps/social-progress_en).

Conversely, the box plots show that early education opportunities are significantly better in noncarbon-intensive than in carbon-intensive regions, regardless of the net migration rate. Areas with both net inward and outward migration are characterised by higher rates of children's participation in preschool education, when these regions are not affected by an increased need to meet environmental requirements. In contrast, carbon-intensive regions offer young residents fewer opportunities for early education. Presumably, such regions face multiple problems due to structural transitions and tend to have limited resources available to invest in social infrastructure that goes beyond basic needs.

There is also a significant difference in the availability of hospital beds calculated per 100 000 inhabitants. Contrary to other indicators, regions with outward migration outperform those with inward migration, regardless of whether they belong to the carbon-intensive or the noncarbon-intensive groups. The improved index in these regions can be explained by the shrinking population, leading to the same number of beds being distributed among fewer people. Alternatively, outward migration raises the percentage of older people, increasing demand for health care. Hence, that may require regions to invest more resources in the provision of health care services.

Changing demographics may also strain the welfare system. As shown in the last box plot of Figure 6, regions with outward migration have a higher percentage of people who experience severe material deprivation. While the aforementioned conclusion can primarily be drawn from the JTF selection, the CINTRAN division suggests that residents of carbon-intensive regions are at higher risk of poverty regardless of whether inward or outward migration prevails. In the face of structural change, the social security system and social rights can be severely challenged, particularly in the affected areas.

A further examination of the mean values and variances for the selected social indicators supports the previous conclusions. Table 1 provides a summary of the average values calculated for the chosen social indicators pertaining to each of the four typology groups.

For most indicators, noncarbon-intensive areas with inward migration had the best mean scores (with the exception of the availability of hospital beds). The carbon-intensive group with outward migration tended to have the lowest overall and sub-component scores for the EU-SPI. However, it outperformed any other regional grouping in terms of the availability of hospital beds. Noncarbon-intensive regions do not take last place in the ranking in any of the cases, even if these regions have outward migration. In contrast, the carbon-intensive group with inward migration often takes a middle place in the ranking, except for access to early education, the availability of hospital beds and the severe material deprivation rate. For these social indicators, carbon-intensive regions with positive net migration perform worse than any other type of region. Note that this mainly implies the CINTRAN sample, and only marginally holds for the JTF selection. This can be explained by a larger number of regions classified as carbon-intensive in the JTF selection than in the CINTRAN selection.

Table 1 also provides a variance analysis for the selected social indicators. Generally, within-group variance is substantial, whereas between-group variance is significantly smaller. However, the latter variance accounts for approximately 20-30% of the total variance for the majority of indicators, suggesting that the proposed division of regions into four groups might (to some extent) explain their performance on many social dimensions.

Finally, we conduct a pairwise comparison of means and summarise the results in Table 2. This analysis aims to assess the differences between the average values of social indicators among the four region groups. The comparison was conducted using pairwise *t*-tests with the Bonferroni *p*-value adjustment method and was expected to define which specific pairs of groups differ significantly from each other in terms of their social indicator means.

Table 1 / Mean values and variances for the selected social indexes by typology group

	Mean values				Analysis of variance		
	CI with in-migration	CI with out-migration	NCI with in-migration	NCI with out-migration	Between groups	Within groups	Total
CINTRAN selection							
EU-SPI	63.033	56.18	70.426	60.953	5898.4	13045.9	18944.3
EU-SPI components							
The basic human needs sub-index	79.083	72.493	82.729	75.900	3016.8	7481.5	10498.3
The foundation of well-being sub-index	62.183	53.253	67.707	59.300	5176.3	15111.3	20287.6
The opportunities sub-index	50.017	44.120	61.866	49.260	10097.1	24711.3	34808.4
Individual social indexes							
Employment rate	72.650	68.940	75.961	66.813	3924.8	12203.4	16128.2
Percentage of children in early education	83.600	85.673	92.696	91.583	977.3	12371.6	13348.9
Hospital beds per 100 000 inhabitants	376.570	573.343	459.890	533.396	377569.9	6261698.9	6639268.8
Severe material deprivation rate	13.733	10.753	4.587	9.545	1174.8	4626.6	5801.4
JTF selection							
EU-SPI	67.553	59.604	70.691	60.173	5542.9	13401.5	18944.4
EU-SPI components							
The basic human needs sub-index	80.935	75.326	82.938	75.171	2894.2	7604.1	10498.3
The foundation of well-being sub-index	65.135	57.321	67.975	58.500	4709.9	15059.5	19769.4
The opportunities sub-index	57.982	47.682	62.143	48.475	9380.5	25427.9	34808.4
Individual social indexes							
Employment rate	74.110	69.321	76.195	66.317	4052.0	12076.2	16128.2
Percentage of children in early education	88.900	88.200	93.109	91.375	638.0	12710.9	13348.9
Hospital beds per 100 000 inhabitants	455.254	531.811	456.343	545.621	328334.4	6310934.4	6639268.8
Severe material deprivation rate	8.039	9.381	4.154	10.113	1144.3	4657.2	5801.5

Note: The columns with mean values provide the average value of social indicators for each typology group calculated on the basis of NUTS2 data. ‘CI with in-migration’ represents carbon-intensive regions with inward migration; ‘CI with out-migration’ denotes carbon-intensive regions with outward migration; ‘NCI with in-migration’ represents noncarbon-intensive regions with inward migration; ‘NCI with out-migration’ refers to noncarbon-intensive regions with outward migration. By comparing the mean values, we aim to assess the degree of variation in the respective indicators across the four types of region, depending on their involvement in decarbonisation and prevailing migration trends. The between-group variance shows how far the four typology group means are from the overall sample mean. The within-group variance measures how far regions are from the sample mean of the group. The total variance measures how much the regions vary around the overall sample mean, ignoring the typology groups, and can be presented as the sum of within-group and between-group variances.
Source: Authors’ calculations.

Table 2 / Pairwise comparison of means for the selected social indexes by typology group

	CI with out-migration vs CI with in-migration	NCI with in-migration vs CI with in-migration	NCI with out-migration vs CI with in-migration	NCI with in-migration vs CI with out-migration	NCI with out-migration vs CI with out-migration	NCI with out-migration vs NCI with in-migration
CINTRAN selection						
.						
EU-SPI	-6.853 (3.599)	7.393* (3.098)	-2.080 (3.190)	14.246*** (2.013)	4.773 (2.151)	-9.473*** (1.129)
EU-SPI components						
The basic human needs sub-index	-6.590* (2.725)	3.645 (2.346)	-3.183 (2.415)	10.235*** (1.524)	3.407 (1.628)	-6.829*** (0.855)
The foundation of well-being sub-index	-8.823* (3.816)	5.508 (3.286)	-2.850 (3.382)	14.331*** (2.134)	5.973** (2.280)	-8.358*** (1.198)
The opportunities sub-index	-5.897 (4.953)	11.949** (4.265)	-0.757 (4.391)	17.746*** (2.771)	5.140 (2.960)	-12.606 (1.555)
Individual social indexes						
Employment rate	-3.710 (3.481)	3.311 (2.997)	-5.837 (3.085)	7.020*** (1.946)	-2.127 (2.080)	-9.147*** (1.092)
Percentage of children in early education	2.073 (4.222)	9.096* (3.740)	7.983 (3.806)	7.023** (2.252)	5.910* (2.360)	-1.113 (1.315)
Hospital beds per 100 000 inhabitants	196.773 (95.784)	83.320 (84.885)	156.826 (86.338)	-113.453 (51.168)	-39.947 (53.545)	73.506* (29.966)
Severe material deprivation rate	-2.980 (3.477)	-9.146** (3.224)	-4.188 (3.281)	-6.166*** (1.527)	-1.208 (1.644)	4.958*** (1.003)
JTF selection						
EU-SPI	-7.949*** (2.125)	3.138 (1.567)	-7.380*** (1.770)	11.087*** (1.702)	0.569 (1.891)	-10.518*** (1,231)
EU-SPI components						
The basic human needs sub-index	-5.609*** (1.600)	2.002 (1.180)	-5.765*** (1.133)	7.611*** (1.282)	-0.154 (1.424)	-7.766*** (0.927)
The foundation of well-being sub-index	-7.814*** (2.252)	2.839 (1.661)	-6.636*** (1.876)	10.653*** (1.804)	1.178 (2.004)	-9.475*** (1.305)
The opportunities sub-index	-10.299*** (2.927)	4.161 (2.159)	-9.507*** (2.438)	14.461*** (2.345)	0.792 (2.604)	-13.668*** (1.696)
Individual social indexes						
Employment rate	-4.789* (2.017)	2.085 (1.488)	-7.793*** (1.680)	6.873*** (1.616)	-3.004 (1.795)	-9.878*** (1.168)
Percentage of children in early education	-0.700 (2.471)	4.209 (1.967)	2.475 (2.108)	4.909* (1.932)	3.175 (2.075)	-1.735 (1.438)
Hospital beds per 100 000 inhabitants	76.557 (56.203)	1.089 (45.128)	90.366 (48.146)	-75.468 (43.507)	13.809 (46.631)	89.278** (32.436)
Severe material deprivation rate	1.342 (1.772)	-3.885* (1.439)	2.074 (1.578)	-5.227 (1.352)	0.732 (1.500)	5.959*** (1.086)

Note: Standard errors are in parentheses. The pairwise comparisons of means were conducted by using pairwise *t*-tests with the Bonferroni *p*-value adjustment method. The hypothesis underlying the pairwise comparison is that there are significant differences in the mean values of the social indicators between the four typology groups. The mean values for each typology group were calculated on the basis of NUTS2 data. *** p<0.01, ** p<0.05, * p<0.10.
Source: Authors' calculations.

For the CINTRAN selection, the results point to the apparent advantage enjoyed by people living in noncarbon-intensive regions. Of the six juxtapositions, only two are characterised by a statistically significant difference in the mean values of the majority of social indicators. The first is the contrast between noncarbon-intensive regions with inward migration and carbon-intensive regions with outward migration. The second refers to the performance of noncarbon-intensive regions with a positive net migration rate, which do relatively better than noncarbon-intensive areas in which outward migration prevails. For the JTF selection, the two distinct contrasts can be supplemented by two additional statistically significant differences. More specifically, carbon-intensive regions with inward migration indicate better performance on most social indicators than carbon-intensive regions with a negative net migration rate. Additionally, such areas have better social conditions than the noncarbon-intensive group in which outward migration prevails.

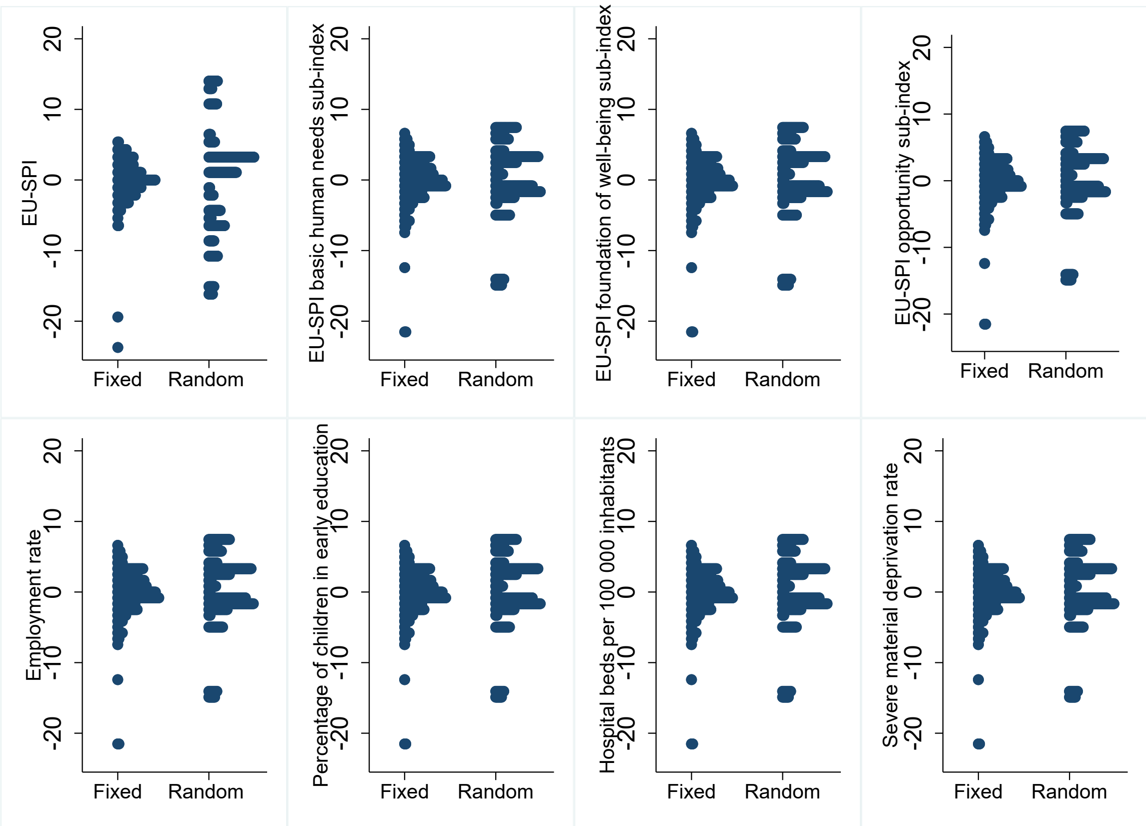
In summary, our descriptive analysis furnishes strong evidence to suggest that both processes – decarbonisation and migration – are linked to (and influence) the variation in the quality of social situations across EU regions. Carbon-intensive regions that face an increased need to introduce structural change to meet environmental requirements have fewer chances to provide their residents with decent opportunities and a better quality of social life than noncarbon-intensive ones. The net migration rate ultimately defines the extent of the deteriorating social situation in those areas. If carbon-intensive regions encounter the problem of negative net migration, their social development is highly likely to take a sharply negative turn. Conversely, if inward migration prevails, areas at risk of decarbonisation tend to show only a mild deterioration and outperform the noncarbon-intensive group with outward migration. Nonetheless, the descriptive analysis also suggests that the variation in social situations across regions may be influenced by the countries' level of prosperity. This implies that a more sophisticated analysis that accounts for a range of possible confounding factors is necessary to fully understand the pattern of changes in the social situation across the four regional groups. We address this issue in the next section by conducting a multilevel analysis of variations in social indicators, while controlling for the regional level of economic and social development.

5. A multilevel analysis of the social situation in the four types of region

To begin with, we take a closer look at variation patterns in our social indexes. More specifically, we calculated a basic random intercept model that included as its key determinants only the binary variables for the four regional types. We further estimated region-level residuals and the random-effects component for the country-level variance. The results are summarised in Figure 7 for both the CINTRAN and the JTF regional groups. The box plots clearly show that the variation in the social situation is attributable to both levels.

Figure 7 / Decomposition of the variation in the social situation between the regional and country levels by social indicator

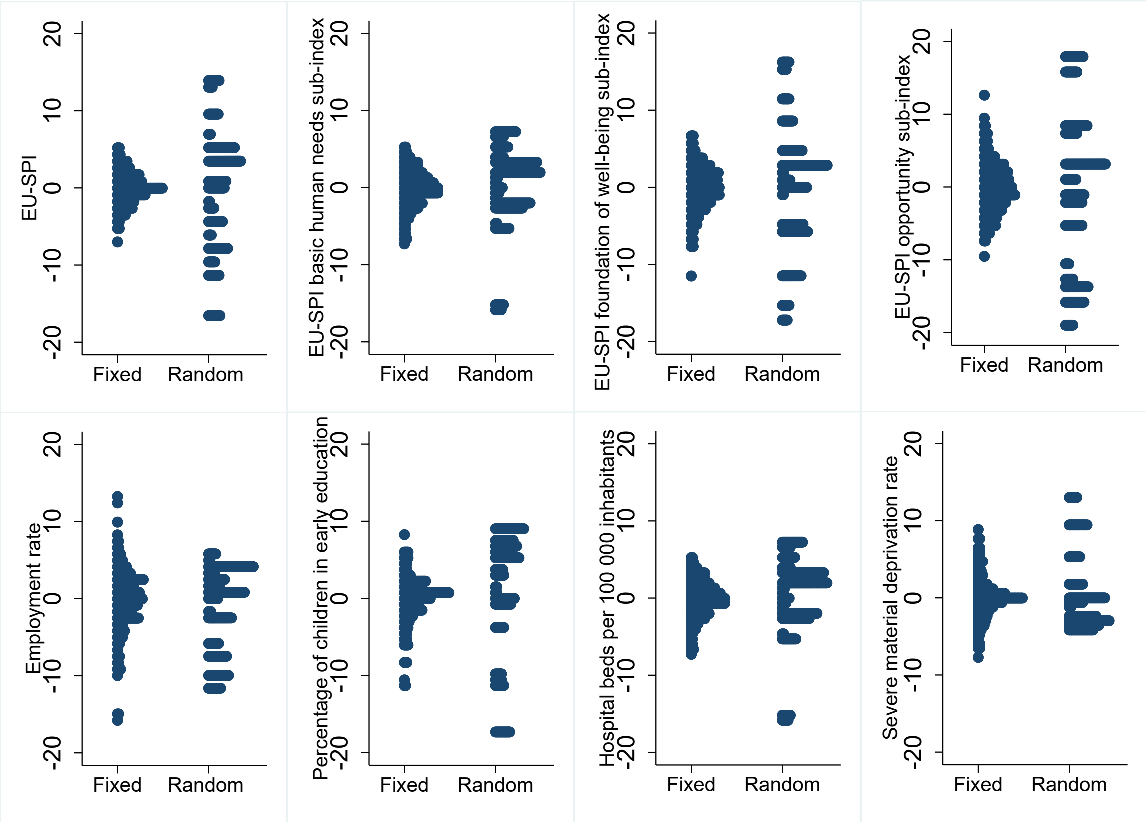
(CINTRAN selection)



Contd.

Figure 7 / Continued

(JTF selection)



Note: Each graph consists of two parts, with the first referring to the fixed-effect component and the second capturing the random-effect component, calculated based on the model with the typology groups as our only predictors. More specifically, the first part reflects the differences between the predicted values and the actual values at the regional level. The second part of each graph accounts for the overall differences in residuals due to country-level variation.
Source: Authors' calculations.

To isolate the four regional groups' effects on the social situation from any economic, infrastructural or social influences, we augmented the random-intercept model with defined control variables. The results are summarised in Table 3 and Table 4. Overall, our analysis suggests that the carbon-intensive group with outward migration is characterised by the worst social situation, regardless of the level of economic development, welfare state regime, population size or road infrastructure. This is especially obvious from the overall EU-SPI and its components: carbon-intensive areas take on significantly lower values than noncarbon-intensive ones, but only if they also have a negative net rate of migration. As soon as inward migration begins to exceed outward migration, such regions tend to improve their overall EU-SPI and components covering basic human needs and the foundation of well-being. Only the most advanced dimension of opportunities shows a relatively similar performance across carbon-intensive regions regardless of their migration outcomes. However, a statistically significant difference was established for the opportunity component between the carbon-intensive group with outward migration and the noncarbon-intensive group where inward migration prevails.

Table 3 / Varying-intercept models with predictors (the CINTRAN selection)

VARIABLES	EU-SP	EU-SPI basic human needs sub-index	EU-SPI foundation of well-being sub-index	EU-SPI opportunities sub-index	Employment rate	Percentage of children in early education	Hospital beds per 100 000 inhabitants	Severe material deprivation rate
Four region types								
Carbon-intensive with out-migration	Ref. category	Ref. category	Ref. category	Ref. category	Ref. category	Ref. category	Ref. category	Ref. category
Carbon-intensive with in-migration	1.836*	3.534***	3.284**	-0.536	5.471**	0.317	-12.84**	-1.886
	(1.102)	(1.282)	(1.546)	(1.625)	(2.162)	(1.992)	(5.624)	(1.974)
Noncarbon-intensive with out-migration	1.081*	1.223*	2.198**	0.059	-0.162	0.211	2.711	-0.575
	(0.630)	(0.733)	(0.883)	(0.929)	(1.230)	(1.038)	(2.925)	(0.927)
Noncarbon-intensive with in-migration	3.911***	3.227***	4.895***	3.678***	6.004***	-0.394	-0.086	-3.451***
	(0.631)	(0.733)	(0.884)	(0.929)	(1.231)	(1.042)	(2.957)	(0.941)
Welfare state types								
Social Democratic	Ref. category	Ref. category	Ref. category	Ref. category	Ref. category	Ref. category	Ref. category	Ref. category
Conservative	-7.859**	-3.296	-9.982***	-9.938***	-1.639	1.321	39.00***	0.314
	(3.160)	(3.401)	(3.456)	(3.770)	(2.697)	(5.266)	(3.930)	(4.051)
Liberal	-9.609*	-7.432	-4.056	-16.69***	-9.150**	5.886	0.001	5.458
	(5.084)	(5.487)	(5.622)	(6.119)	(4.653)	(7.622)	(0.000)	(5.336)
Southern European	-16.06***	-7.206**	-18.32***	-21.38***	-5.362*	-4.339	13.85***	3.204
	(3.325)	(3.583)	(3.651)	(3.980)	(2.909)	(4.982)	(4.240)	(3.473)
Post-communist	-16.67***	-10.29***	-18.39***	-20.62***	3.821	-8.878**	43.64***	3.001
	(2.945)	(3.181)	(3.263)	(3.550)	(2.712)	(4.433)	(4.435)	(3.141)
GDP per capita	0.013***	0.005***	0.007***	0.024***	0.019***	-0.000	0.024**	-0.009***
	(0.001)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.009)	(0.003)
Accessibility of roads	-0.010	-0.036**	-0.007	0.012	-0.015	-0.006	-0.095*	0.043**
	(0.012)	(0.014)	(0.017)	(0.017)	(0.023)	(0.021)	(0.054)	(0.020)
Population size	-0.002***	-0.003***	-0.006***	0.000	-0.002	-0.001	-0.002	0.002
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.004)	(0.001)
Constant	73.39***	85.63***	73.49***	61.96***	66.22***	95.50***	21.99***	6.053*
	(2.747)	(2.999)	(3.165)	(3.421)	(3.058)	(4.221)	(6.092)	(3.210)
SD at the country level	18.155***	20.919***	21.276***	25.405***	11.404***	40.139***	10.674*	18.315***
	(5.715)	(6.642)	(6.985)	(8.260)	(4.179)	(13.372)	8.669)	(6.486)
SD at the region level	3.788***	5.135***	7.492**	8.274***	14.979***	10.284***	9.619***	7.977***
	(0.372)	(0.505)	(0.731)	(0.815)	(1.471)	(1.153)	(1.293)	(0.962)
Observations	229	229	229	229	229	179	176	156
Number of groups	22	22	22	22	22	20	19	19

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
Source: Authors' calculations.

Table 4 / Varying-intercept models with predictors (the JTF selection)

VARIABLES	EU-SP	EU-SPI basic human needs sub-index	EU-SPI foundation of well-being sub-index	EU-SPI opportunities sub-index	Employment rate	Percentage of children in early education	Hospital beds per 100 000 inhabitants	Severe material deprivation rate
Four region types								
Carbon-intensive with out-migration	Ref. category	Ref. category	Ref. category	Ref. category	Ref. category	Ref. category	Ref. category	Ref. category
Carbon-intensive with in-migration	1.602** (0.662)	1.303* (0.768)	2.459*** (0.942)	1.187 (0.974)	5.742*** (1.286)	-0.158 (1.156)	-1.778 (3.284)	-1.237 (1.052)
Noncarbon-intensive with out-migration	-0.621 (0.579)	-0.292 (0.672)	-0.285 (0.823)	-1.316 (0.851)	0.267 (1.122)	0.409 (0.953)	2.255 (2.673)	0.679 (0.876)
Noncarbon-intensive with in-migration	2.690*** (0.555)	2.195*** (0.644)	2.890*** (0.790)	2.805*** (0.817)	6.446*** (1.080)	-0.260 (0.920)	-1.175 (2.642)	-2.824*** (0.867)
Welfare state types								
Social Democratic	Ref. category	Ref. category	Ref. category	Ref. category	Ref. category	Ref. category	Ref. category	Ref. category
Conservative	-7.865** (3.188)	-3.269 (3.390)	-9.956*** (3.448)	-9.978*** (3.854)	-1.693 (2.692)	1.316 (5.261)	38.40*** (4.038)	0.251 (4.022)
Liberal	-9.307* (5.128)	-7.190 (5.472)	-4.023 (5.618)	-16.16*** (6.251)	-8.941* (4.653)	5.819 (7.618)	0.001 (0.000)	5.018 (5.300)
Southern European	-16.13*** (3.354)	-7.176** (3.570)	-18.29*** (3.644)	-21.57*** (4.066)	-5.447* (2.903)	-4.314 (4.976)	13.17*** (4.343)	3.210 (3.447)
Post-communist	-16.96*** (2.969)	-10.50*** (3.169)	-18.77*** (3.257)	-20.88*** (3.622)	3.773 (2.704)	-8.879** (4.426)	42.84*** (4.534)	3.138 (3.113)
GDP per capita	0.013*** (0.001)	0.005*** (0.002)	0.008*** (0.002)	0.024*** (0.002)	0.019*** (0.003)	-0.000 (0.003)	0.024** (0.010)	-0.009*** (0.003)
Accessibility of roads	-0.010 (0.012)	-0.036** (0.014)	-0.008 (0.017)	0.015 (0.018)	-0.016 (0.023)	-0.008 (0.021)	-0.094* (0.056)	0.043** (0.020)
Population size	-0.002*** (0.000)	-0.002*** (0.001)	-0.006*** (0.001)	0.000 (0.001)	-0.002 (0.001)	-0.001 (0.001)	-0.002 (0.004)	0.001 (0.001)
Constant	74.80*** (2.723)	86.93*** (2.936)	75.59*** (3.096)	62.92*** (3.404)	66.07*** (2.914)	95.51*** (4.138)	23.08*** (5.888)	5.101* (3.078)
SD at the country level	4.552*** (0.668)	4.638*** (0.694)	5.129*** (0.796)	5.416*** (0.835)	3.533*** (0.659)	6.226*** (0.967)	3.295** (1.489)	4.272*** (0.748)
SD at the region level	1.949*** (0.095)	2.266*** (0.111)	2.787*** (0.134)	2.878*** (0.141)	3.890*** (0.192)	3.206*** (0.179)	9.836*** (0.569)	2.792*** (0.168)
Observations	229	229	229	229	229	179	176	156
Number of groups	22	22	22	22	22	20	19	19

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
Source: Authors' calculations.

Nonetheless, this pattern of variation in social conditions across regions undergoes a profound alteration when the analysis focuses on the four individual measures. Only on the employment rate do carbon-intensive regions with outward migration perform significantly worse than both carbon- and noncarbon-intensive groups with inward migration. By contrast, no statistically significant difference is found with regard to the availability of preschool education across the four regional groups. Also, there is a marginal difference between carbon-intensive regions with inward and outward migration on the measure of the availability of hospital beds: regions with outward migration have more hospital beds available to their residents than regions with inward migration. Finally, a substantially larger proportion of the population in carbon-intensive areas with outward migration experiences severe material deprivation, compared to the population in noncarbon-intensive regions with a positive net migration rate. Note that these conclusions are equally applicable to both the CINTRAN and JTF selections.

As far as the major control variables are concerned, their influence is in line with our expectations. The Social Democratic welfare states, characterised as they are by universal social provisions and high levels of decommodification, outperform other types on a wide range of social indicators. By contrast, the Post-communist and Southern European countries had the worst social situation. The Liberal and Conservative welfare states took the middle position. With the exception of the availability of preschool education, an increase in the level of economic development (as measured by GDP per capita) could lead to an improvement in the social situation. Richer regions have more resources to invest in their social infrastructure to improve their overall social situation and the quality of social rights provided to their residents.

In addition, population size was found to be inversely related to the regional social situation, primarily in the case of the overall EU-SPI and its components. In particular, larger population size is associated with lower scores for overall EU-SPI and its components. Larger populations may reflect the greater size of regions – and hence more problems to deal with. Having to administer the social infrastructure in big regions, where people’s preferences can be increasingly diverse, can result in a substantial reduction in the performance of those regions in terms of social rights and social progress. Surprisingly, we found no strong systematic relationship between accessibility by road and the social situation. Population size and level of economic development explained most of the variation across regions.

We proceeded with the analysis by estimating a model with random intercepts and coefficients. To facilitate the interpretation of the results, we limited the range of regional variables to the key one – the carbon-intensive group with outward migration. The main research question we asked was whether such regions are characterised by a worse social situation, and whether this varies across countries. Table 5 summarises the results for the random intercept and coefficient models for the CINTRAN sample. The coefficient on the regional dummy suggests that carbon-intensive areas do not on average have significantly worse social conditions, as measured by the eight social indexes. However, the random effect estimates reveal that this difference is not stable, but tends to change from country to country. This is especially true of the overall EU-SPI and its components.

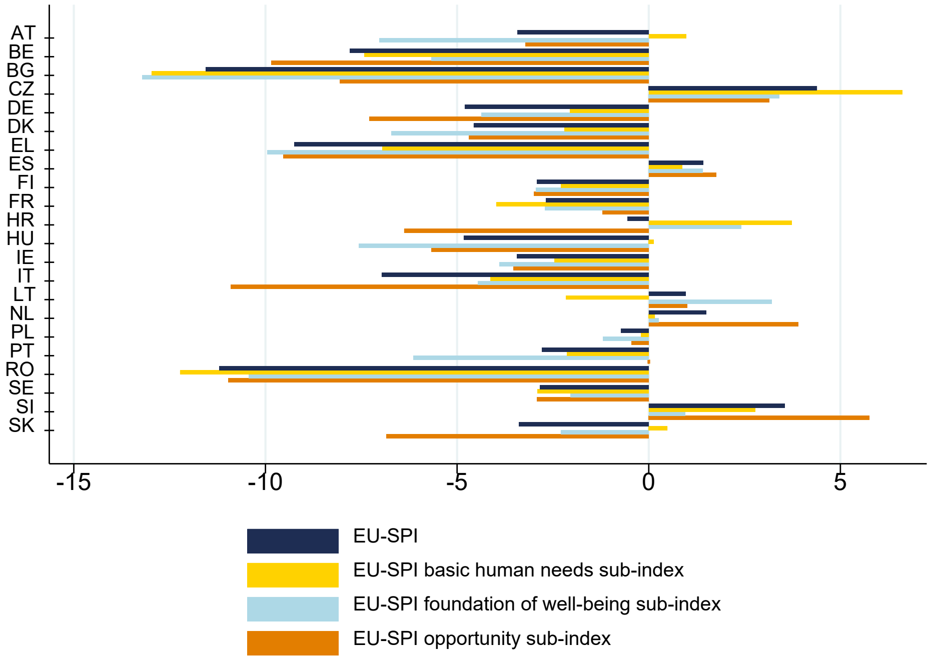
Table 5 / Varying-intercept and varying-coefficient models with predictors (the CINTRAN selection)

VARIABLES	EU-SP	EU-SPI basic human needs sub-index	EU-SPI foundation of well-being sub-index	EU-SPI opportunities sub-index	Employment rate	Percentage of children in early education	Hospital beds per 100 000 inhabitants	Severe material deprivation rate
Carbon-intensive with out-migration	-3.441	-2.464	-3.901	-3.532	-3.746*	-2.334	-0.594	2.356
Welfare state types	(2.314)	(2.493)	(2.456)	(2.614)	(1.929)	(3.227)	(3.231)	(2.325)
Social Democratic	Ref. category	Ref. category	Ref. category	Ref. category	Ref. category	Ref. category	Ref. category	Ref. category
Conservative	-8.016**	-3.353	-10.14***	-10.19***	-1.859	1.309	38.72***	0.002
	(3.562)	(3.838)	(3.704)	(3.932)	(2.476)	(5.522)	(3.892)	(4.326)
Liberal	-9.676*	-7.506	-4.109	-16.75***	-9.475**	6.143	0.000	5.632
	(5.731)	(6.173)	(6.024)	(6.404)	(4.481)	(7.980)	0.000	(5.704)
Southern European	-15.70***	-6.973*	-18.01***	-21.01***	-6.836***	-4.573	13.00***	2.953
	(3.569)	(3.845)	(3.737)	(3.970)	(2.646)	(4.975)	(4.193)	(3.555)
Post-communist	-17.71***	-11.45***	-19.84***	-21.08***	3.739	-7.985*	43.11***	2.668
	(3.311)	(3.567)	(3.484)	(3.705)	(2.596)	(4.627)	(4.450)	(3.345)
GDP per capita	0.015***	0.006***	0.009***	0.027***	0.024***	-0.001	0.019**	-0.013***
	(0.001)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.009)	(0.003)
Accessibility of roads	0.000	-0.031**	0.005	0.029	0.007	0.001	-0.104*	0.020
	(0.013)	(0.014)	(0.018)	(0.019)	(0.026)	(0.021)	(0.055)	(0.021)
Population size	-0.002***	-0.003***	-0.006***	0.000	-0.003	-0.001	-0.002	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.004)	(0.001)
Constant	75.49***	87.76***	76.49***	63.07***	68.09***	95.07***	24.92***	6.526**
	(3.032)	(3.265)	(3.285)	(3.506)	(2.923)	(4.298)	(5.677)	(3.300)
SD at the country level								
SD (CI with out-migration)	4.985***	5.231***	5.396***	5.487***	3.083***	6.465***	2.869	4.592***
	(0.674)	(0.707)	(0.771)	(0.781)	(0.578)	(0.916)	(1.539)	(0.754)
SD at the region level	2.198***	2.353***	2.928***	3.192***	4.564***	3.241***	10.063***	3.046***
	(0.110)	(0.118)	(0.147)	(0.160)	(0.226)	(0.186)	(0.588)	(0.190)
Observations	229	229	229	229	229	179	176	156
Number of groups	22	22	22	22	22	20	19	19

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
Source: Authors' calculations.

To identify which countries will be influenced most adversely, we estimated the best linear unbiased predictors of the random effects, which show the amount of variation for the estimated beta coefficients (u_1). Then, we estimated the slopes for each country regression line as $\_b[x_1] + u_1$ by limiting these calculations to the overall EU-SPI and its components. Figure 8 illustrates the results and suggests that the regions most affected tend to be in the Southern European and Post-communist groups of countries (Greece, Italy, Bulgaria, Hungary and Romania). Of the old EU member states, only Belgium shows a significant drop in the quality of social progress due to the transition to a climate-neutral economy.

Figure 8 / Overall change in social progress and its sub-indexes due to belonging to a carbon-intensive region with outward migration, by country



Note: The graph displays the best linear unbiased predictors of the random effect associated with belonging to a carbon-intensive region on the EU-SPI overall score and its individual components, considering each country separately. The graph consists of four bars for each country. The first represents the random effect for the EU-SPI overall score, while the remaining three bars represent the random effects for the EU-SPI components. This presentation allows for an examination of the country-specific impact of belonging to a carbon-intensive region on the EU-SPI overall score and its sub-indexes. The analysis is conducted at the NUTS2 regional level. To avoid potential bias, countries where NUTS2 coincides with the entire national territory were excluded from the analysis.
Source: Authors' calculations.

For the JTF sample, we calculated a random intercept and coefficient model differently. We included the whole range of the regional groups and allowed their effects to vary across countries. Since the results are more complex with the four group types, we did not produce a graph of the findings. The estimates point, nonetheless, to the existence of a cross-country variation in the impact of various regional groups on the social situation (see Table 6 below).

The fact that social situations in the affected regions vary across EU member states raises the question of the key factors that predict this variation. The most reasonable explanation is that the ultimate deterioration in the quality of social indicators is defined in carbon-intensive areas by the country's overall performance. To demonstrate this, we chose three variables – the level of economic development, welfare state design and the quality of the road infrastructure – and divided the regions into three groups with low, average and high levels of performance on GDP per capita and the accessibility of regions by road. Additionally, we created five binary variables for the welfare state; each united countries that belong to one of the welfare regime types – Social Democratic, Conservative, Liberal, Southern European and Post-communist. By allowing interactions between the four regional groups and one of the country-level variables each time, we modelled the variation in the social situation across the four types of region, depending on the countries' social, economic or infrastructural characteristics.

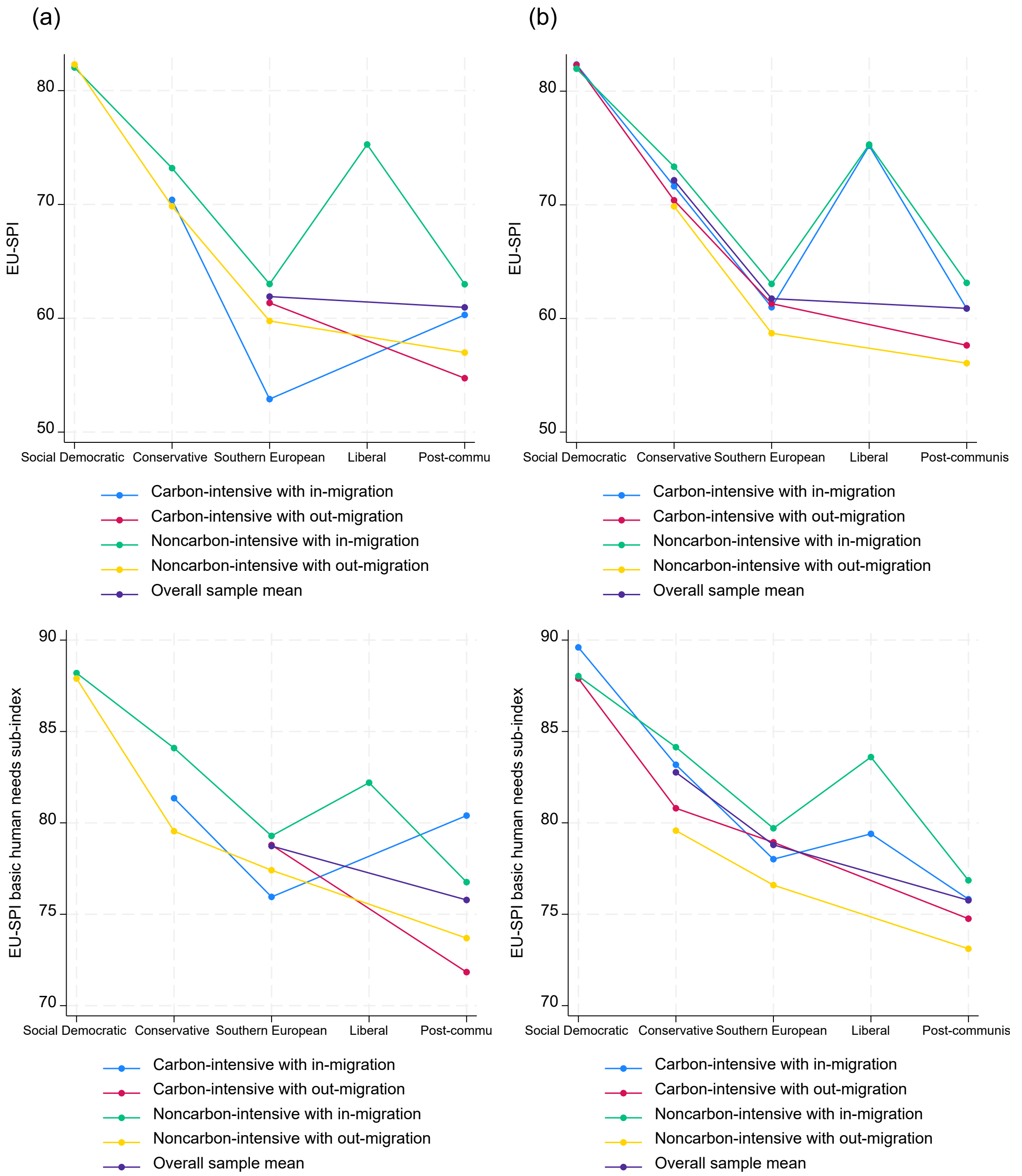
Table 6 / Varying-intercept and varying-coefficient models with predictors (the JTF selection)

VARIABLES	EU-SP	EU-SPI basic human needs sub-index	EU-SPI foundation of well-being sub-index	EU-SPI opportunities sub-index	Employment rate	Percentage of children in early education	Hospital beds per 100 000 inhabitants	Severe material deprivation rate
Four region types								
Carbon-intensive with out-migration	Ref. category	Ref. category	Ref. category	Ref. category	Ref. category	Ref. category	Ref. category	Ref. category
Carbon-intensive with in-migration	1.722***	1.247	2.667***	1.164	5.067***	0.484	-2.985	-1.622
	(0.652)	(0.782)	(0.919)	(0.958)	(1.248)	(1.155)	(3.175)	(1.279)
Noncarbon-intensive with out-migration	-0.714	-0.343	-0.649	-1.262	-0.031	0.290	2.768	0.843
	(0.719)	(0.678)	(1.061)	(1.042)	(1.699)	(0.930)	(3.713)	(0.990)
Noncarbon-intensive with in-migration	2.750***	2.170***	3.118***	2.659***	5.701***	0.144	-2.434	-2.557***
	(0.551)	(0.670)	(0.777)	(0.810)	(1.009)	(1.064)	(2.627)	(0.831)
Welfare state types								
Social Democratic	Ref. category	Ref. category	Ref. category	Ref. category	Ref. category	Ref. category	Ref. category	Ref. category
Conservative	-7.911**	-3.304	-10.03***	-9.949**	-1.865	1.541	39.17***	0.455
	(3.214)	(3.428)	(3.379)	(3.944)	(2.638)	(5.668)	(3.487)	(3.813)
Liberal	-9.267*	-7.412	-4.034	-16.09**	-9.036**	6.233	0.000	4.491
	(5.162)	(5.518)	(5.495)	(6.378)	(4.509)	(8.161)	(0.000)	(5.052)
Southern European	-16.00***	-7.364**	-17.85***	-21.68***	-4.612	-3.195	11.20***	2.887
	(3.381)	(3.606)	(3.571)	(4.159)	(2.840)	(5.346)	(3.812)	(3.267)
Post-communist	-16.89***	-10.80***	-18.56***	-20.78***	3.248	-8.181*	41.32***	3.283
	(2.990)	(3.200)	(3.190)	(3.698)	(2.625)	(4.752)	(4.057)	(2.952)
GDP per capita	0.013***	0.005**	0.008***	0.024***	0.020***	-0.000	0.022**	-0.008***
	(0.001)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.009)	(0.003)
Accessibility of roads	-0.009	-0.039***	-0.007	0.017	-0.013	-0.008	-0.106**	0.023
	(0.012)	(0.014)	(0.017)	(0.017)	(0.022)	(0.021)	(0.053)	(0.020)
Population size	-0.003***	-0.002**	-0.006***	0.000	-0.003*	-0.001	-0.001	0.003**
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.004)	(0.001)
Constant	74.780***	87.38***	75.26***	62.99***	66.36***	94.49***	26.41***	5.785**
	(2.736)	(2.965)	(3.029)	(3.456)	(2.786)	(4.415)	(5.428)	(2.928)
SD at the country level								
SD (CI with in-migr.)	dropped	0.000	dropped	0.663	1.834	dropped	8.014**	2.458***
		(0.000)		(2.283)	(1.379)		(3.684)	(0.983)
SD (NCI with in-migr.)	dropped	0.527	dropped	0.000	0.000	dropped	3.177	0.000
		(1.212)		(0.000)	(0.000)		(2.191)	(0.000)
SD (NCI with out-migr.)	dropped	0.483	dropped	2.075	4.427***	dropped	9.128***	1.681*
		(1.079)		(0.819)	(1.216)		(2.804)	(0.890)
SD (cons)	dropped	4.658***	dropped	5.509***	3.593***	dropped	0.000	4.046***
		(0.701)		(0.852)	(0.666)		(0.000)	(0.744)
SD at the region level	dropped	2.246***	dropped	2.767	3.464***	dropped	8.934***	2.595***
		(0.120)		(0.144)	(0.194)		(0.558)	(0.166)
Observations	229	229	229	229	229	179	176	156
Number of groups	22	22	22	22	22	20	19	19

Note: Standard errors in parentheses. Random effect parameters for Columns 1, 3 and 6 were not calculated, suggesting that there is no varying-coefficient component for the regional group effects in these models. *** p<0.01, ** p<0.05, * p<0.1
Source: Authors' calculations.

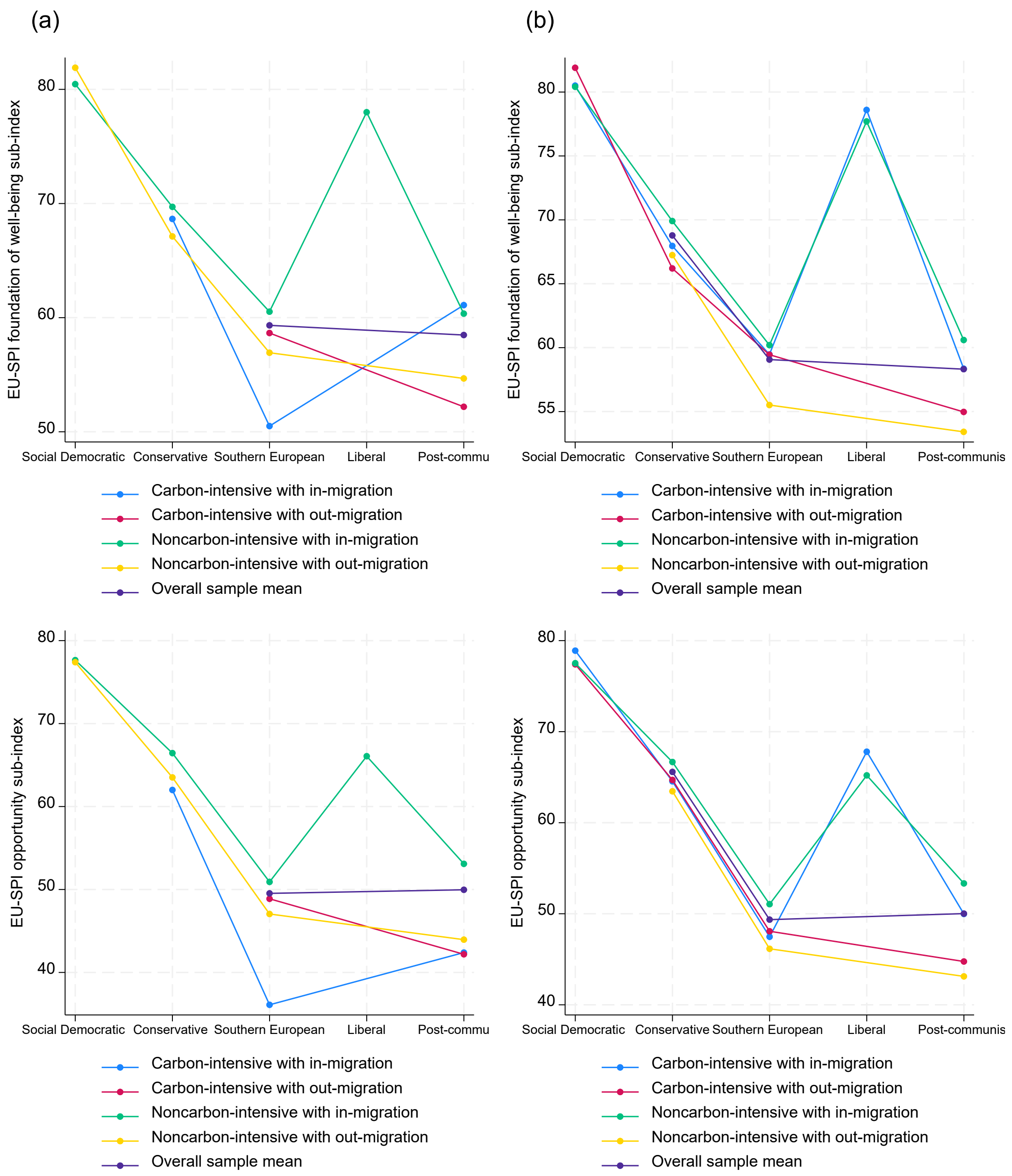
Figure 9 shows that carbon-intensive regions (the blue and red lines) can approach the noncarbon-intensive regions in terms of their social performance, if they are located in countries with a Social Democratic or Conservative welfare state system. Those two welfare regimes tend to offer generous social provisions, universal education and a solid healthcare system. These features become important factors in weakening the link between the social situation and migration/decarbonisation processes. By contrast, regions in the Liberal, Southern European or Post-communist groups, where low levels of social protection and high levels of social inequality prevail, are unable to create decent social conditions for their residents during the transition to a carbon-neutral economy.

Figure 9 / Visualisation of interactions between the four typology groups and welfare state regimes on the selected social indexes ((a) the CINTRAN selection and (b) the JTF selection)



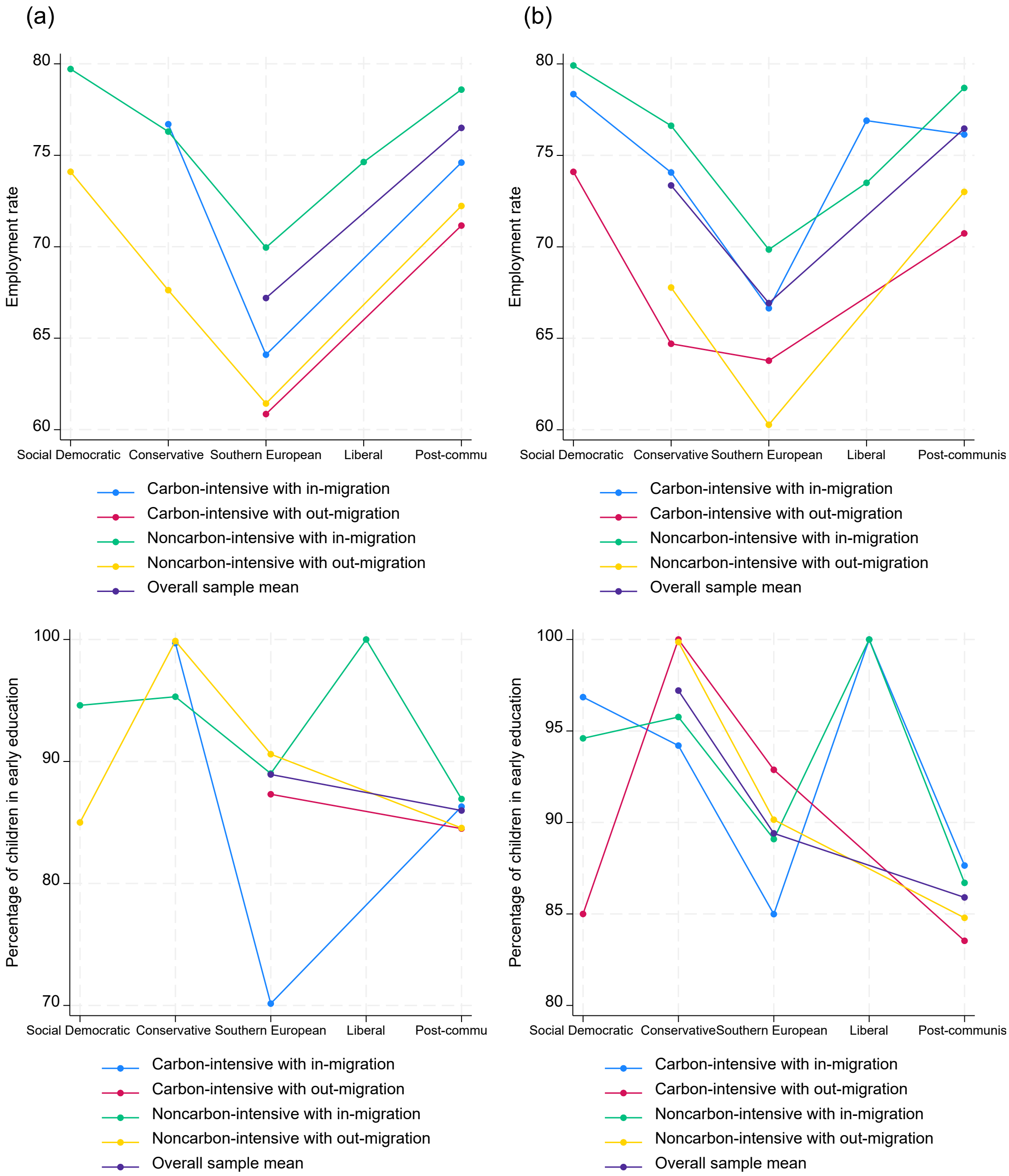
Contd.

Figure 9 / Continued



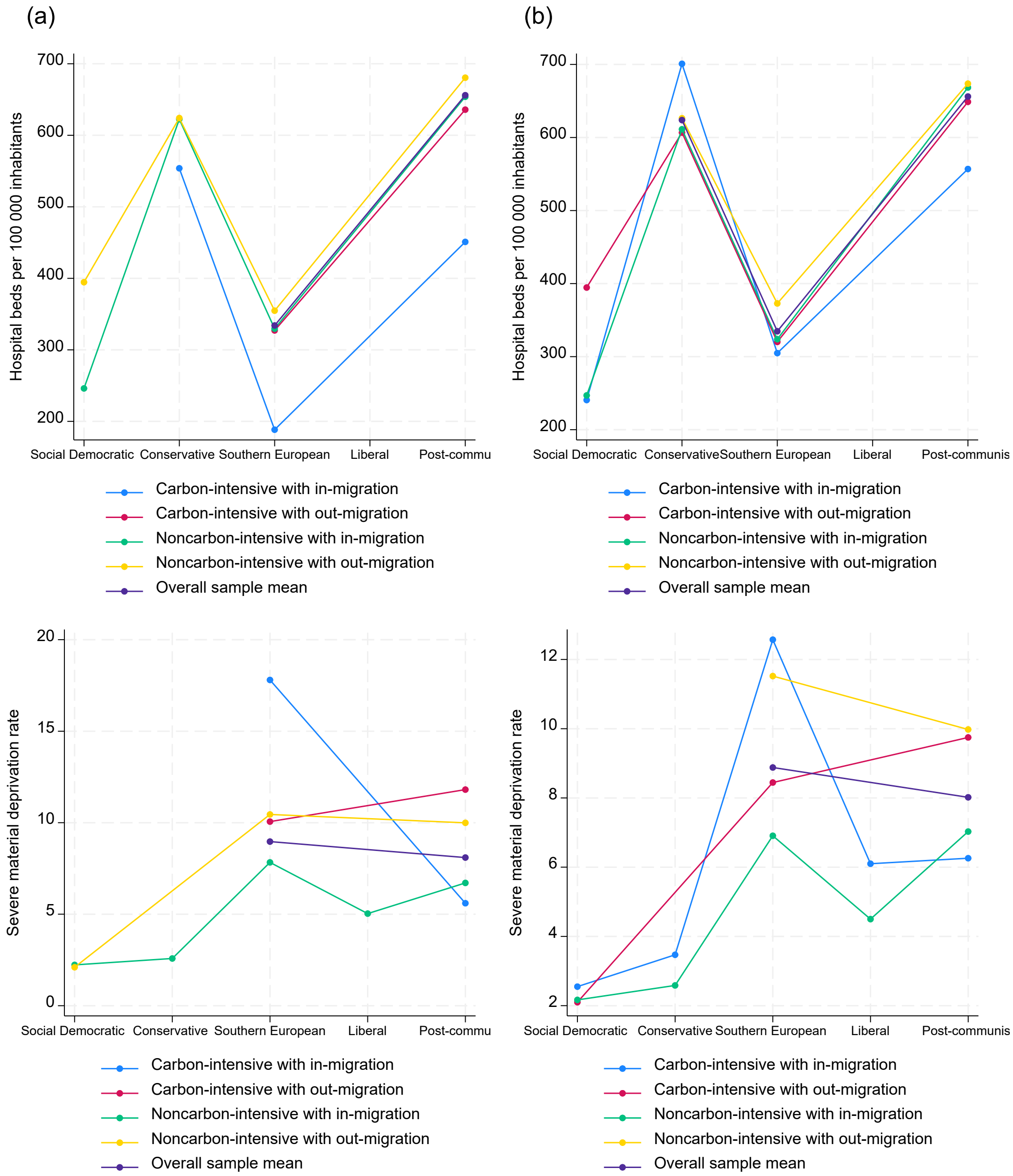
Contd.

Figure 9 / Continued



Contd.

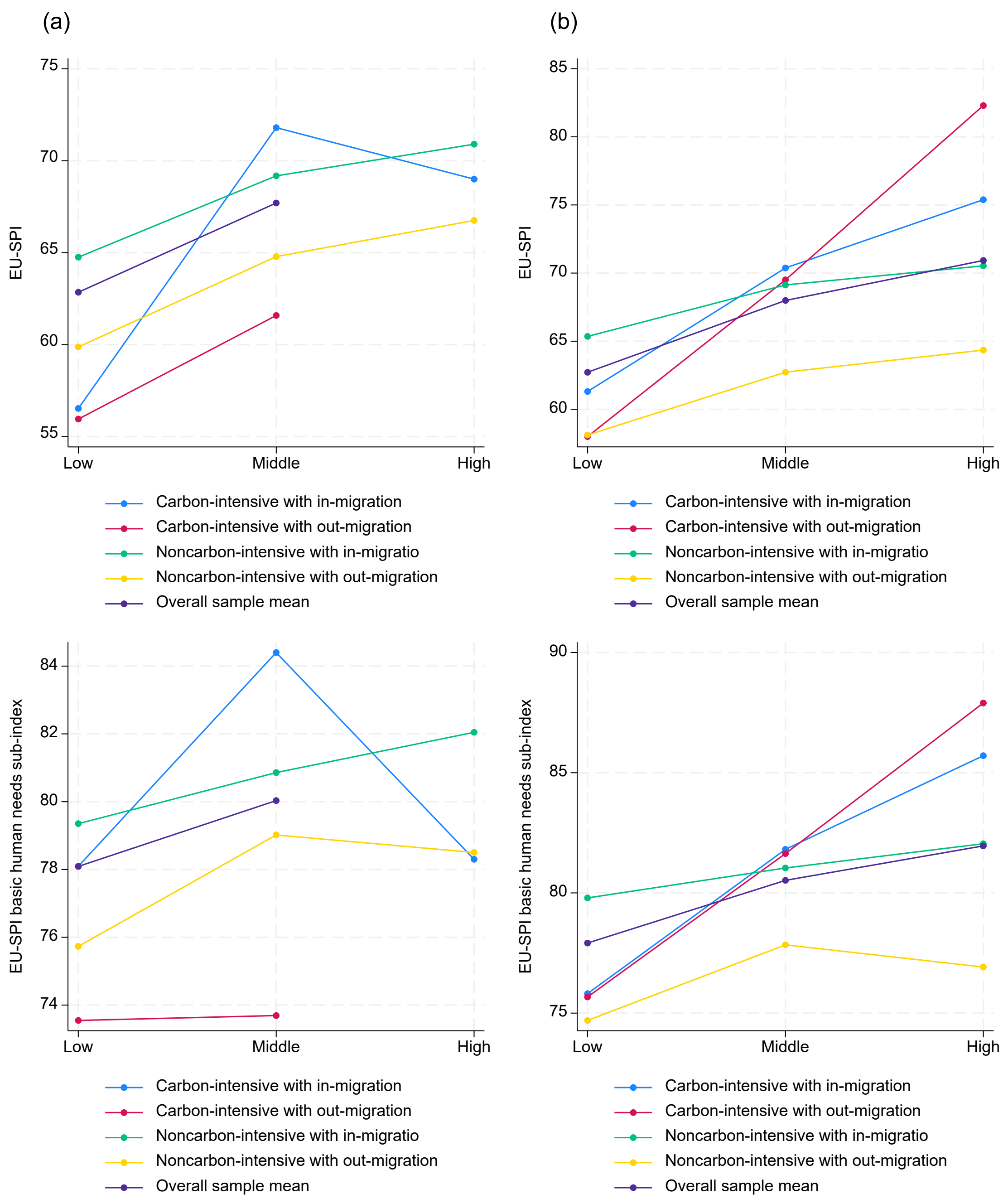
Figure 9 / Continued



Note: The graph displays the predicted values of selected social indicators, which have been averaged for five distinct categories of welfare state. These predictions were made at the NUTS2 regional level. To maintain objectivity, countries in which the NUTS2 level encompasses the entire national territory were excluded from the analysis (see Section 2 for a comprehensive explanation). Due to a substantial number of missing values for certain social indicators, some graphs do not include representative regions for specific welfare state regimes.
Source: Authors' calculations.

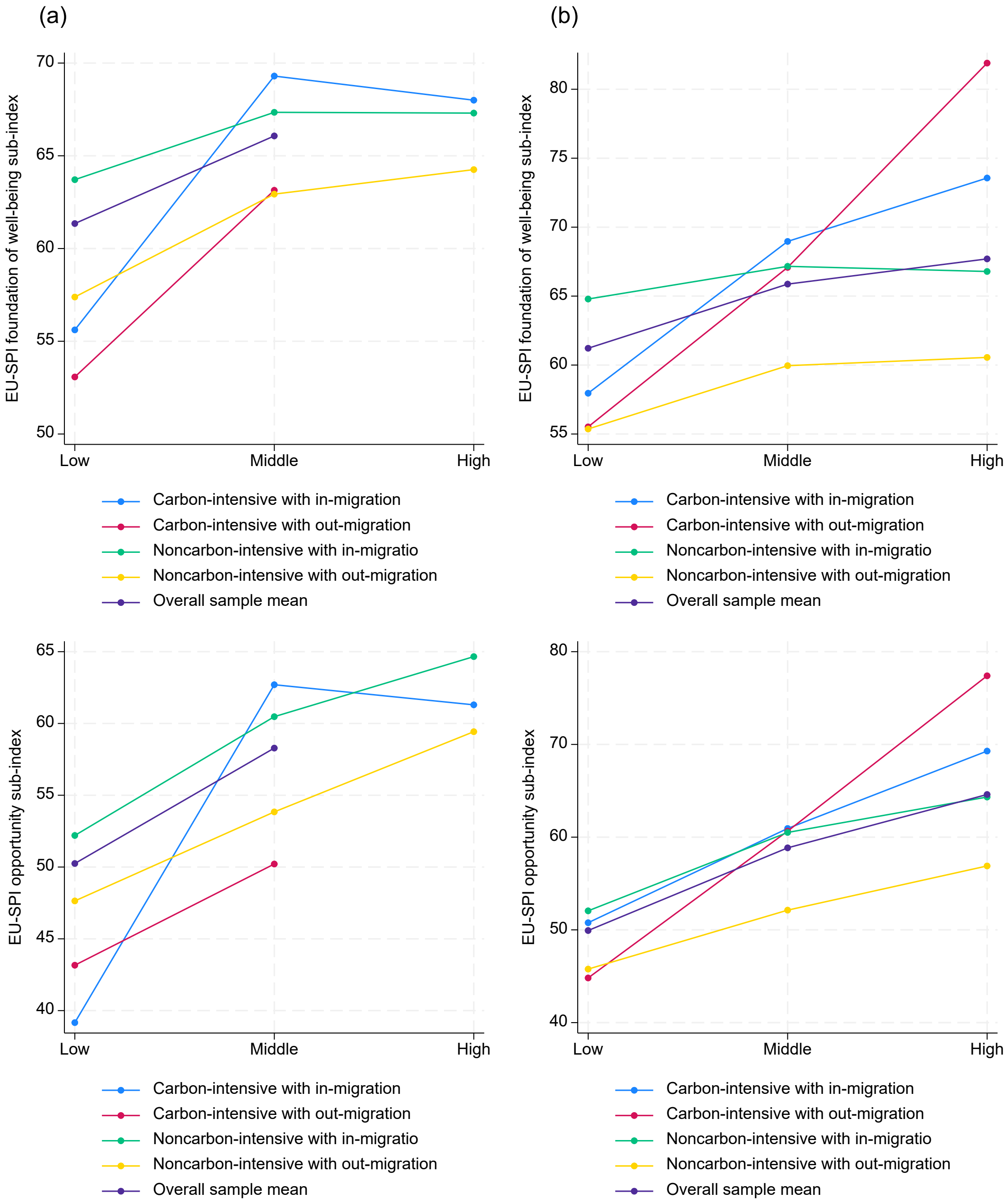
Similarly, the relationship between the four regional groups and the overall EU-SPI and its components demonstrates a heavy dependence on their countries' economic prosperity levels (see Figure 10 below). In most of the cases, carbon-intensive regions depicted by the blue and the red colours in the graphs perform significantly better in terms of the social situation if the country is more economically developed. Economic prosperity may relate closely to the amount of resources that a country can channel to the affected regions to improve their attractiveness and minimise the negative impacts of structural shifts or outmigration. This link is less obvious, however, for selected indicators, such as the employment rate, the availability of hospital beds or the risk of severe material deprivation. The EU's recent focus on these aspects may explain why many member states have managed to detach their employment, healthcare and poverty policies from the issue of economic development.

Figure 10 / Visualisation of interactions between the four typology groups and the lower, middle and upper-income levels of GDP per capita on the selected social indexes ((a) the CINTRAN selection and (b) the JTF selection)



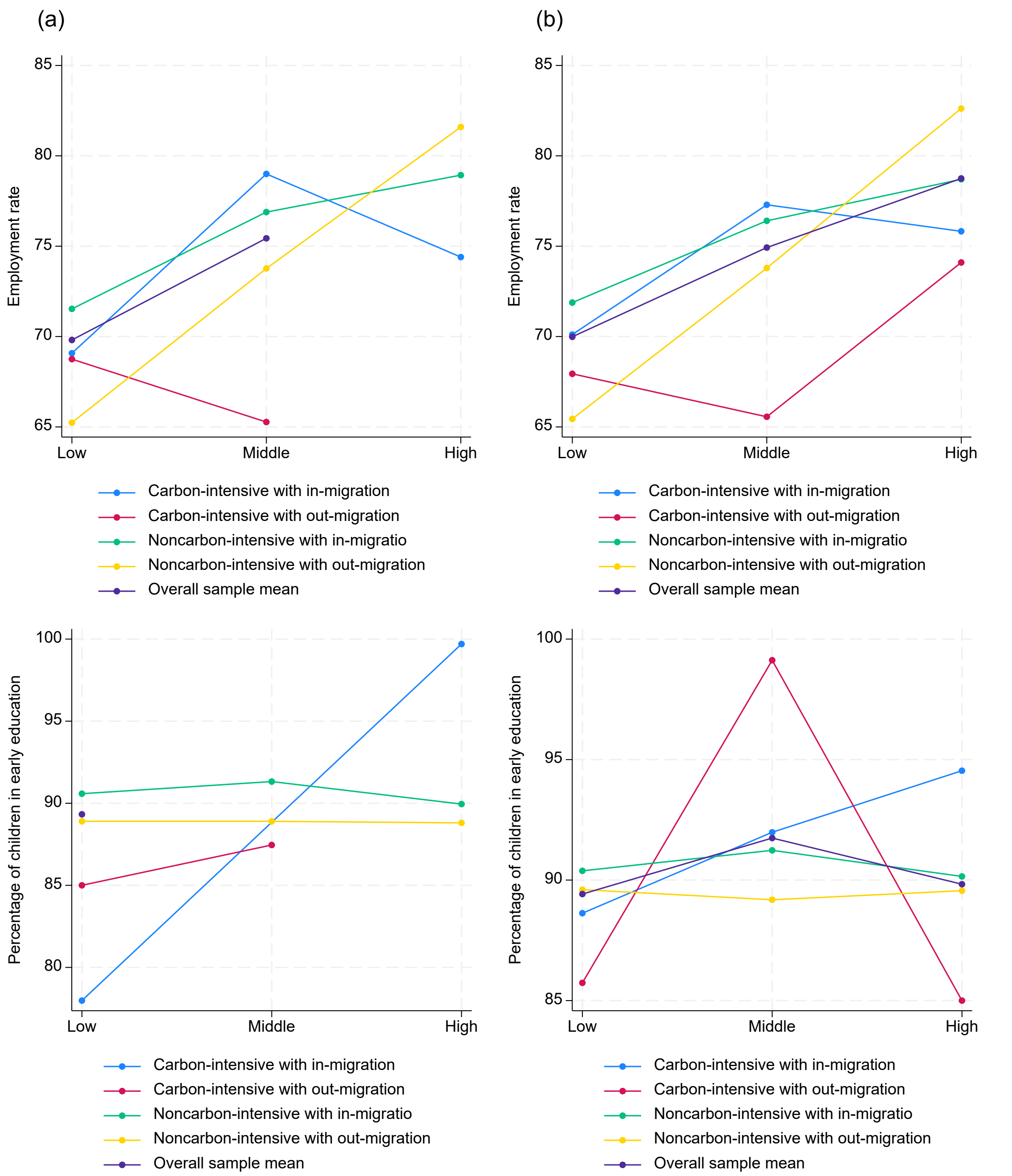
Contd.

Figure 10 / Continued



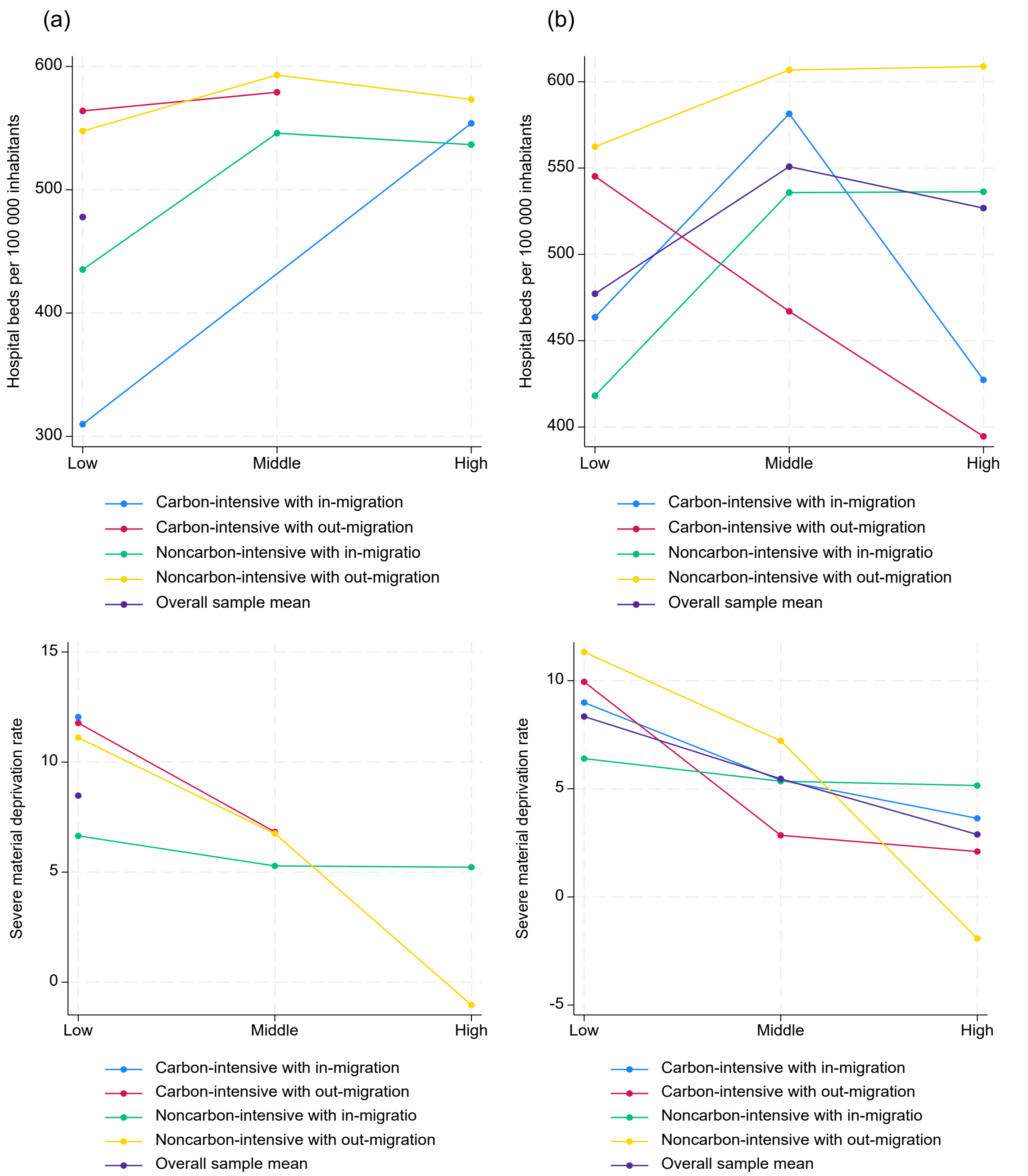
Contd.

Figure 10 / Continued



Contd.

Figure 10 / Continued

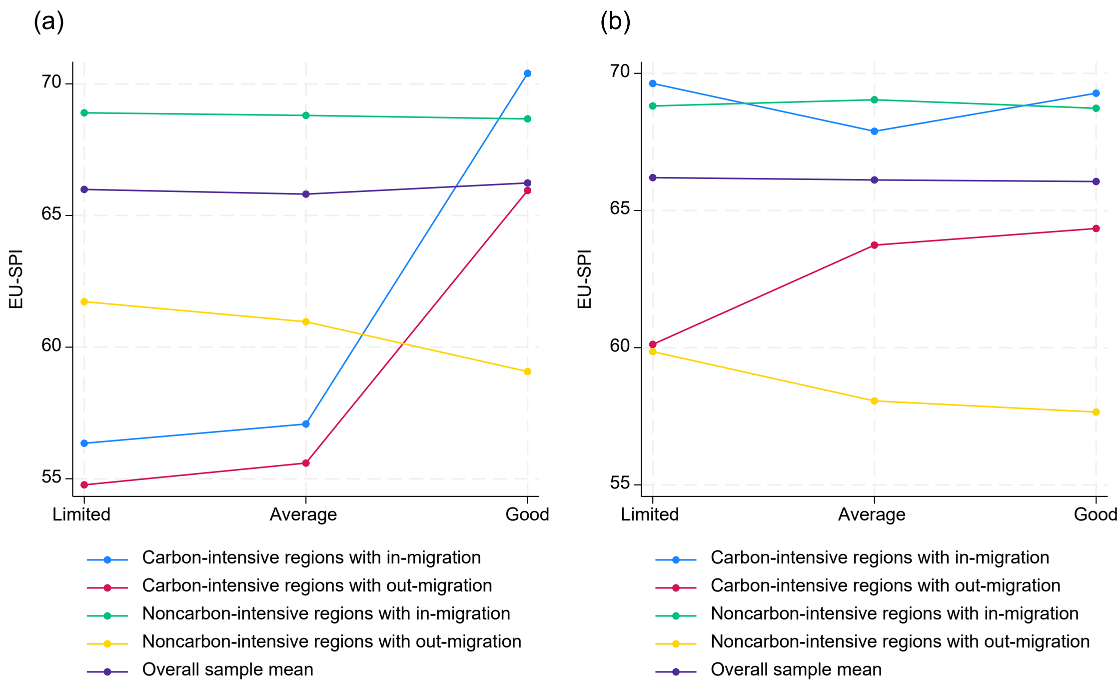


Note: The graph displays the predicted values of selected social indicators, which have been averaged across three distinct groups based on GDP per capita levels. The countries were categorised on the basis of their GDP per capita ranking. Drawing upon this ranking, they were subsequently divided into three equally sized income groups: lower-, average- and upper-income countries. The predictions were made at the NUTS2 regional level. To maintain objectivity, countries in which the NUTS2 level encompasses the entire national territory were excluded from the analysis (see Section 2 for further details). Due to a substantial number of missing values for certain social indicators, some graphs do not include representative regions for particular income groups.
Source: Authors' calculations.

Finally, Figure 11 below shows that differences in the social situation across the four types of region can be a function of their road infrastructure. Countries that effectively connect regions by road have better social indicators. Broad road networks can partially offset the worsening economic or social conditions in the affected regions by allowing commuting to neighbouring areas. That may mitigate the negative impact caused by structural change on local societies or economies in meeting environmental requirements.

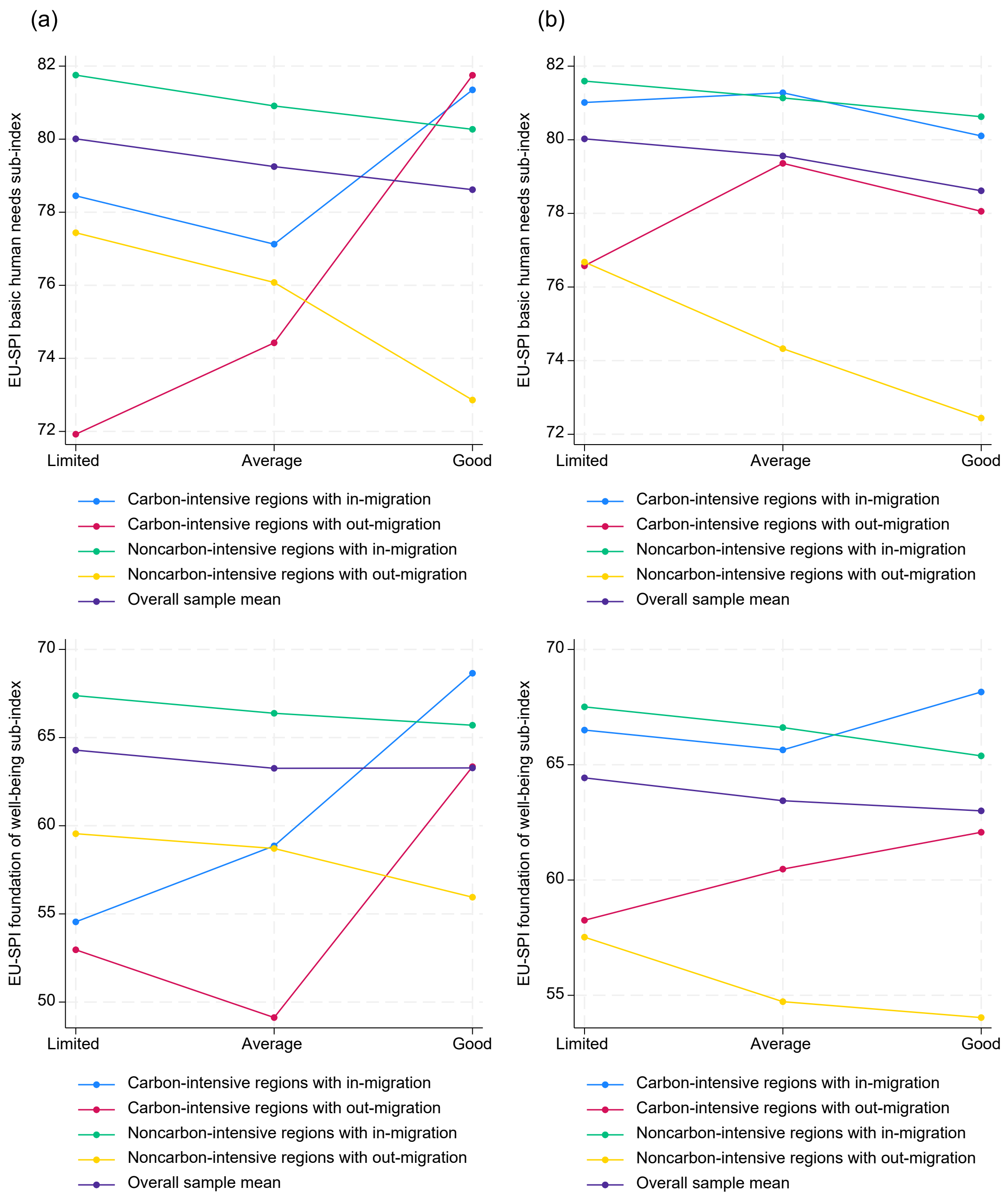
Overall, our analysis shows that carbon-intensive regions – and especially those with outward migration – face a severe deterioration of their social situation during the transition to a climate-neutral economy. This trend constitutes, however, a complex phenomenon and does not affect all EU countries in the same way. We expect the final regional effect to depend on many factors that relate to the overall level of economic, social and infrastructural development of the countries. This implies that carbon-intensive areas should receive special attention and be subject to increased economic and social measures, especially if they belong to the group of less-developed EU member states.

Figure 11 / Visualisation of interactions between the four typology groups and limited, average and good road accessibility on selected social indexes ((a) the CINTRAN selection and (b) the JTF selection)



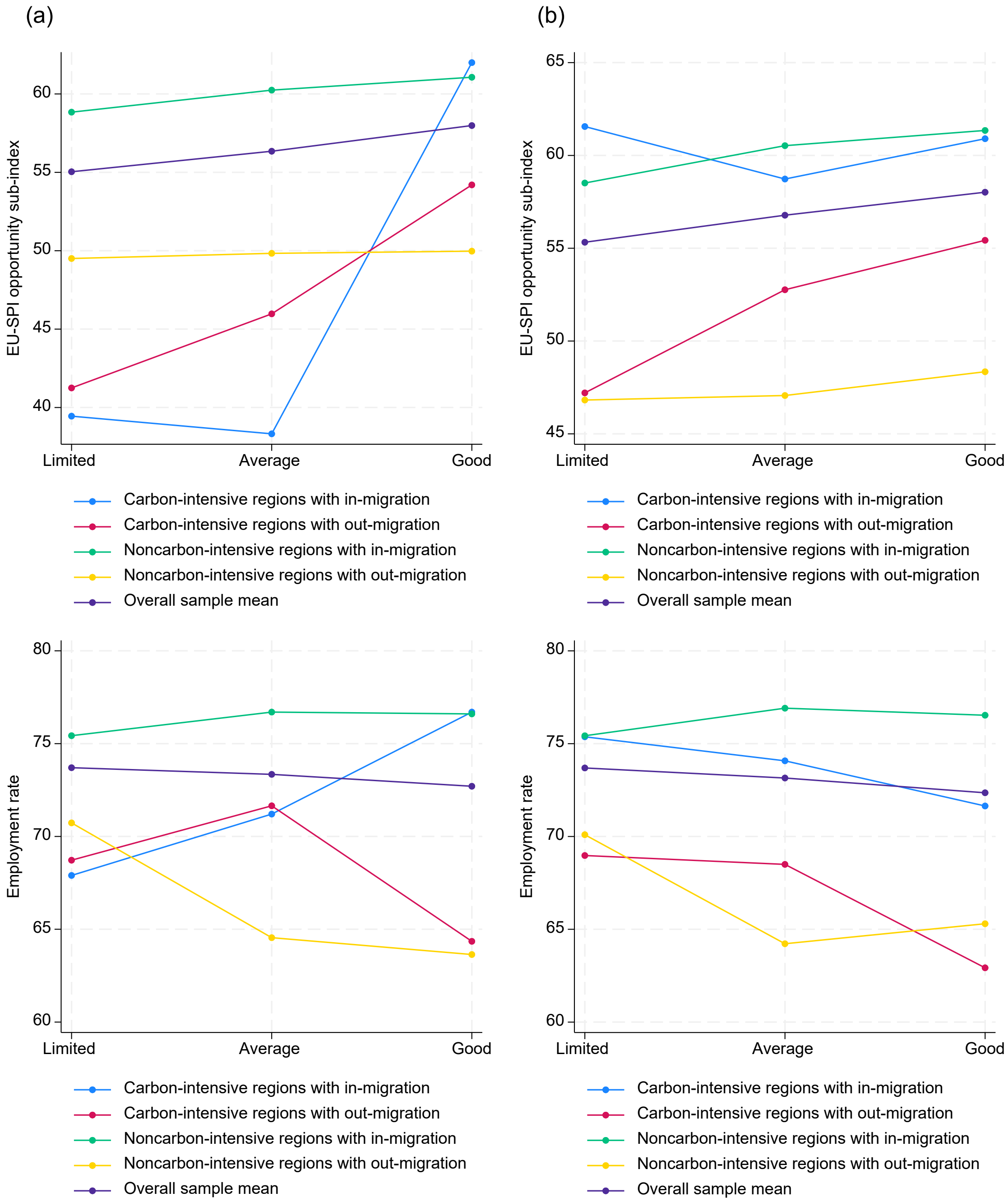
Contd.

Figure 10 / Continued



Contd.

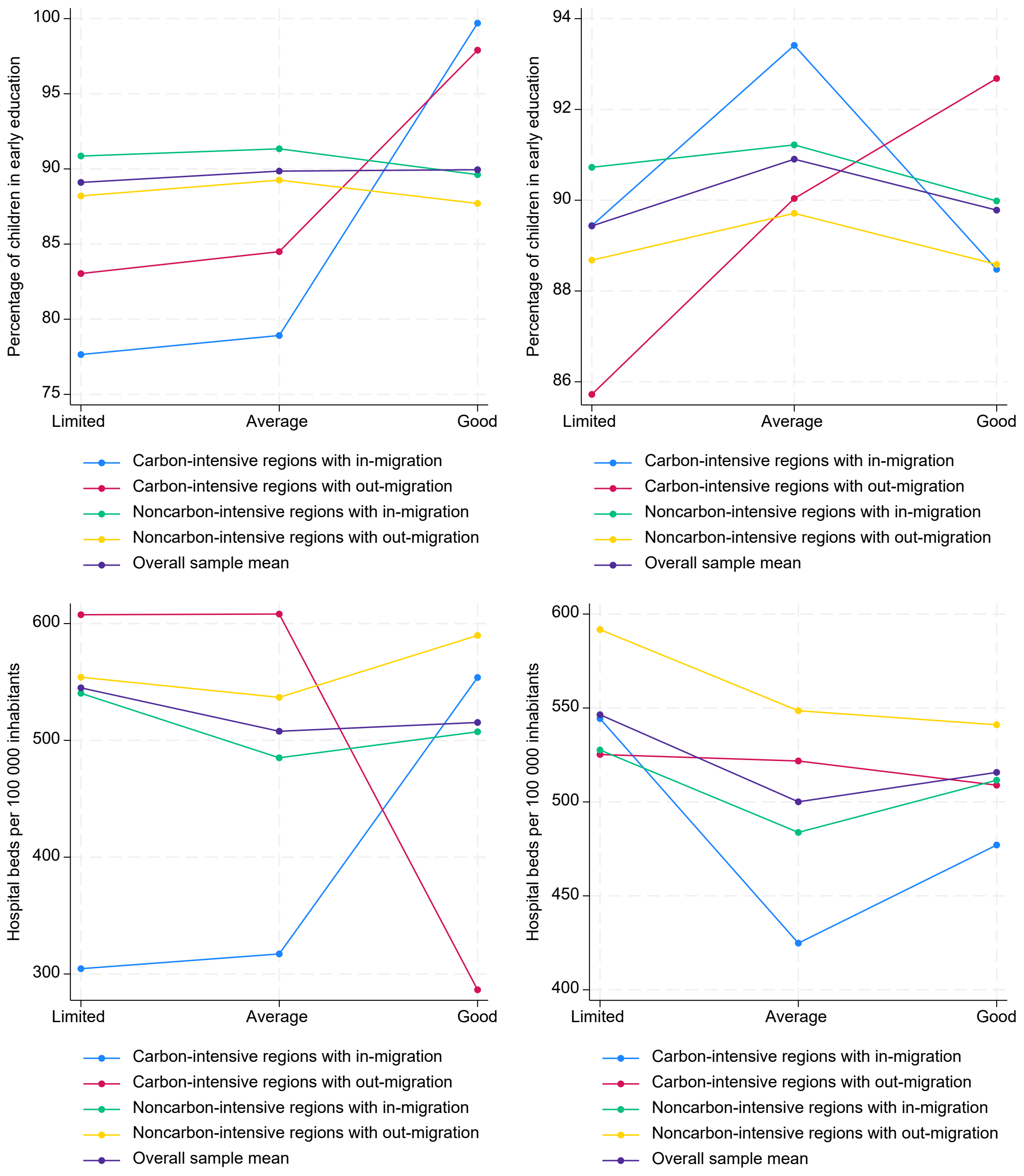
Figure 10 / Continued



Contd.

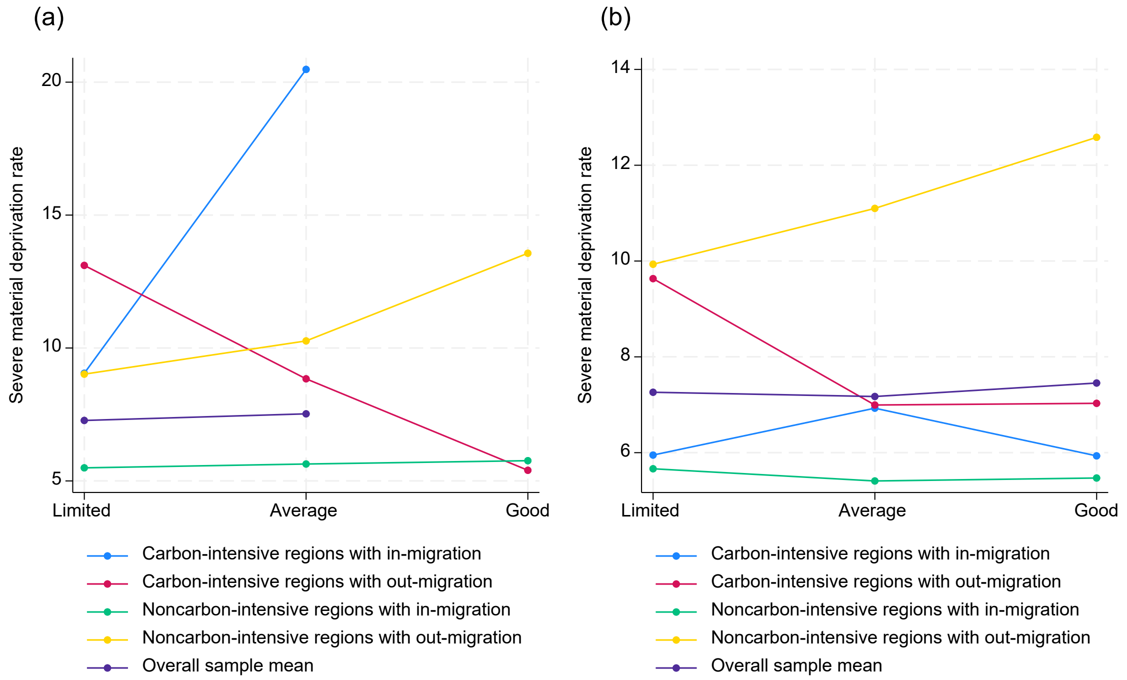
Figure 10 / Continued

(a) (b)



Contd.

Figure 10 / Continued



Note: The graph displays the predicted values of selected social indicators, which have been averaged across three distinct groups on the basis of overall road accessibility. The countries were grouped by creating a ranking based on the roads accessibility index. The predictions were made at the NUTS2 regional level. To maintain objectivity, countries in which the NUTS2 level encompasses the entire national territory were excluded from the analysis (see Section 2 for further details). Due to a substantial number of missing values for certain social indicators, some graphs do not include representative regions for particular road accessibility groups.
Source: Authors' calculations.

6. Conclusions and discussions

This study has focused on analysing what impact the shift to a climate-neutral economy might have on EU regions. We commenced our investigation by linking the process of decarbonisation to migration. Our key premise was that carbon-intensive regions are more likely to experience outward migration than non-affected areas. Drawing on the existing research, we stressed the need to account for both processes – decarbonisation and migration – when discussing social developments surrounding the issue of meeting environmental requirements. The two processes are likely to be interdependent, with decarbonisation often leading to intense out-migration.

By combining the information on the structural change due to decarbonisation and migration outcomes, we were able to identify four regional groups: (1) carbon-intensive with outward migration; (2) carbon-intensive with inward migration; (3) noncarbon-intensive with outward migration; and (4) noncarbon-intensive with inward migration. We suggested that this typology could effectively reveal the kind of problems that regions may face in the transition to a climate-neutral economy. By describing each regional type, we hypothesised that the carbon-intensive group with outward migration would perform badly in terms of the social situation, due to the double challenge faced by their economies and societies. Noncarbon-intensive regions were expected to outperform any other grouping, though they face the risk of falling behind if their net migration rates turn negative.

We substantiated the validity of these arguments by thoroughly examining the variations in the social indicators across the four regional types. Through both descriptive and multilevel analyses, compelling evidence was provided to indicate that carbon-intensive regions consistently exhibit lower performance across a broad spectrum of social indicators, compared to other regional types. However, the performance of carbon-intensive regions is contingent upon the overall economic, social and infrastructural conditions within each country. Our findings demonstrate that carbon-intensive regions with outward migration have the potential to approximate the social progress observed in other regional types if they exhibit a high level of economic development, if they implement more universal and generous social provisions, and if their road infrastructure leads to improved accessibility.

These findings enable us to draw some conclusions with significant policy implications for the transition towards a climate-neutral economy. First, it is crucial to pay special attention to carbon-intensive regions, in order to mitigate the adverse effects of structural change resulting from decarbonisation. Not only should there be financial support for the transition to alternative energy sources, but also a comprehensive understanding of the drivers behind outward migration from those areas affected. The EU should give priority to a combination of restructuring efforts in carbon-intensive regions, with effective economic and social policies to forestall out-migration and foster sustainable development.

Secondly, the finding that carbon-intensive regions, including those experiencing outward migration, can exhibit favourable levels of social progress in economically developed countries implies that substantial funding channelled towards the regions affected can offset the negative consequences associated with decarbonisation and out-migration. Hence, EU leaders should consider the provision of long-term financial aid to carbon-intensive areas, in order to make those regions more appealing for their residents in terms of living and employment opportunities.

Thirdly, the observation that a broader framework for organising social provision can partially mitigate the adverse impacts of decarbonisation, particularly when combined with emigration, raises the question of whether financial assistance to residents in carbon-intensive regions should be provided on a non-means-tested basis. Implementing a more universal, non-means-tested approach to social provision on a national scale presents significant challenges. However, it may offer a viable and effective means of temporarily supporting individuals in affected areas. Adopting a more universal social policy has the potential to minimise the negative consequences of structural shifts and serve as an incentive for individuals to remain in the region.

In summary, the transition to a climate-neutral economy can disproportionately impact vulnerable regions and their residents, resulting in potential unfairness. Relying solely on funding for private initiatives, as outlined by the Just Transition Fund, may have limited effectiveness. Individual initiatives may provide partial or fragmented solutions that only marginally address the multifaceted challenges faced by affected regions, thus offering limited improvements to the social situation of the local population. In contrast, the magnitude of structural shifts and their adverse consequences can be significant.

Consequently, any attempt to address these negative consequences necessitates comprehensive policymaking through a multitude of wide-ranging measures that should be implemented and funded at the EU level in order to maximise their impact. In addition to financial support, such measures should entail the establishment of a special status for these regions, ensuring the provision of universal and far-reaching opportunities for their residents, at least temporarily. It is worth noting that the carbon-intensive group identified by E3 Modelling includes only 21 regions that could easily become the focal point for intensified policymaking efforts. While this represents a small fraction of all the regions in EU member states, it has the potential to significantly improve the quality of life for millions of people.

References

Annoni, P. and P. Bolsi (2020) The Regional Dimension of Social Progress in Europe: Presenting the new EU Social Progress Index. Luxembourg: Publications Office of the European Union.

Biagi, B. and K.R. Dotzel (2018) Theoretical Advances on Interregional Migration Models. In B. Biagi, A. Faggian, I. Rajbhandari and V.A. Venhorst, *New Frontiers in Interregional Migration Research* (pp. 21-47). Heidelberg: Springer.

European Commission (2017) Concluding Report: Social Summit for Fair Jobs and Growth – Gothenburg, Sweden.

European Commission (2021a) *The European Pillar of Social Rights Action Plan*. Luxembourg: Publications Office of the European Union.

European Commission (2021b) Regulation (EU) 2021/1056 of the European Parliament and of the Council of 24 June 2021 establishing the Just Transition Fund, PE/5/2021/REV/1. Brussels: Official Journal of the European Union.

European Commission (2021c) Commission Staff Working Document on the Territorial Just Transition Plans, SWD(2021) 275. Brussels: Directorate-General for Regional and Urban Policy.

Greenwood, M. (1997) Internal Migration in Developed Countries. In Mark R. Rosenzweig and Oded Stark (eds), *Handbook of Population and Family Economics* (pp. 647–720). Amsterdam: Elsevier.

Kahanec, M. and K. Zimmermann (2009) Migration in an Enlarged EU: A Challenging Solution? Economic Papers 363. Brussels: Directorate-General for Economic and Financial Affairs Publications.

Kreft, I. and J. De Leeuw (1998) *Introducing Multilevel Analysis.* Thousand Oaks, CA: Sage Publications.

OECD (2012) Demographic Change and Local Development: Shrinkage, Regenerations and Social Dynamics. Paris: OECD Publishing.

Özgen, C., P. Nijkamp and J. Poot (2011) Immigration and Innovation in European Regions. IZA Discussion Papers, No. 5676. Bonn: Institute for the Study of Labor (IZA).

Potančoková, M., M.J. Stonawski and N. Gailey (2021) Migration and Demographic Disparities in Macro-regions of the European Union, a View to 2060. *Demographic Research*, 45, 1317–1354.

Rodríguez-Pose, A. (2018) The Revenge of the Places that Don't Matter (and what to do about it). *Cambridge Journal of Regions, Economy and Society*, 11(1), 189-209.

Sayegh, S. (2017) Outward Migration May Alter Population Dynamics and Income Inequality. *Nature Climate Change,* 7, 828-832.

Snijders, T. and R.J. Bosker (1999) *Multilevel Analysis: An Introduction to the Basic and Advanced Modeling.* Thousand Oaks, CA: Sage Publications.

Wirth, W., M. Hofer and H. Schramm (2012) Beyond Pleasure: Exploring the Eudaimonic Entertainment Experience. *Human Communication Research*, 38, 406-428.

Zimmermann, K. (2005) European Labour Mobility: Challenges and Potentials. *De Economist*, 153(4), 425-450.

IMPRESSUM

Herausgeber, Verleger, Eigentümer und Hersteller:
Verein „Wiener Institut für Internationale Wirtschaftsvergleiche“ (wiiw),
Wien 6, Rahlgasse 3

ZVR-Zahl: 329995655

Postanschrift: A 1060 Wien, Rahlgasse 3, Tel: [+431] 533 66 10, Telefax: [+431] 533 66 10 50
Internet Homepage: www.wiiw.ac.at

Offenlegung nach § 25 Mediengesetz: Medieninhaber (Verleger): Verein "Wiener Institut für Internationale Wirtschaftsvergleiche", A 1060 Wien, Rahlgasse 3. Vereinszweck: Analyse der wirtschaftlichen Entwicklung der zentral- und osteuropäischen Länder sowie anderer Transformationswirtschaften sowohl mittels empirischer als auch theoretischer Studien und ihre Veröffentlichung; Erbringung von Beratungsleistungen für Regierungs- und Verwaltungsstellen, Firmen und Institutionen.