
On Lagging Versus Leading Regions in the European Union by Competitiveness-Density-Vitality Predictors

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Abstract:

Purpose: This paper aims to develop a comparable and robust framework for assessing human development at the NUTS 3 regional level within the European Union, addressing both measurement and classification challenges.

Design/methodology/approach: The study constructs a Regional Human Development Index (RHDI) based on three core dimensions—economic capital, socio-human capital, and health—drawing on EUROSTAT data. Unlike the traditional UNDP Human Development Index, the proposed index employs factor score aggregation to reduce compensatory effects among dimensions. In addition, a typology of regions is developed using cluster analysis, enabling a multidimensional classification of regions into categories such as lagging, middle-developed, and leading regions. The validity of both the index and typology is tested through multivariate analysis using predictors related to competitiveness, density, and demographic vitality.

Findings: The results reveal significant spatial disparities in human development across the European Union at the NUTS 3 level. Lagging regions are predominantly located in Eastern and South-Eastern Europe, while leading regions are concentrated in Northern and Western member states. The analysis confirms that higher levels of competitiveness, population density, and demographic vitality are strongly associated with higher regional human development. Furthermore, the typological approach provides additional explanatory power by capturing qualitative differences between regions that are not fully reflected in index-based measures.

Practical implications: The proposed framework offers policymakers a more granular and analytically robust tool for identifying regional inequalities and targeting cohesion policies. By combining index measurement with typological classification, the study supports more nuanced, place-based policy interventions within the European Union.

Originality/value: This research represents one of the first comprehensive attempts to measure and classify human development at the NUTS 3 level across the EU using a data-driven aggregation method. It contributes to the literature by integrating index and typology approaches and by introducing the competitiveness–density–vitality (CDV) framework.

Keywords: Human development, regional inequality, RHDI, NUTS 3 regions, European Union, competitiveness-density-vitality.

JEL Codes: R11, O15, C38, I31, O18.

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1. Introduction

Human development encompasses more than economic development. One of the ways to measure human development that has gained widespread acceptance is the Human Development Index (Lind, 2019), which is published annually by the United Nations Development Programme (UNDP). The index takes into account economic, educational/knowledge and health aspects. The UNDP variant of the Human Development Index (HDI) operationalises the concept of total capital (Emery and Flora, 2006) at the country level.

Total capital can also be operationalised and measured at the regional or local level (Komorowski *et al.*, 2020; Sandu, 2022). However, these measurements are rarely designed to be universally comparable across large geographical areas. That is what this text proposes to do. A measure such as this can be used to assess the similarities and differences in human development between the NUT 3 regions across the entire European Union (EU).

One of the critical points with the index is that its aggregation, by arithmetic or geometric mean, allows for compensation effects (Natoli *et al.*, 2024). The alternatives, to avoid this shortcoming, would be to aggregate indicators in the index of human development by Condorcet algorithm or, not so usually, to identify the patterns of human development-poverty by a typology or multicriteria classification not allowing for compensation effects. When to use the index and when the typology? This is the basic question we formulate about measuring human development at the regional level of NUTS 3 in the European Union.

Another critical point on HDI is related to input dimensions. Some authors criticise the fact that HDI, in the UNDP version, used only education, income and health as key input dimensions, neglecting, for example, the quality of the environment as measured by CO₂ emissions and material footprint (Hickel, 2020; Dörffel and Schuhmann, 2022). Dividing HDI (geometric mean of education, life expectancy and a modified form of income after computing it by min-max of logarithms values of income) by the ecological index is the proposed solution for the sustainable development index (Hickel, 2020).

A supplementary advantage of a human development typology is in the area of its prediction or explanation. Having the typology of human development as a dependent variable one can accept, easier, the hypothesis that the explanatory factors could be different for different classes. The use of index and typology measures is a way to do sensitivity analysis (Treiman, 2014) that could serve as a validation method. One could also interpret the classification of patterns of human development typology as values of partially ordered variables.

The index and the typology measuring human development at the regional level are conceived in the spirit of the development concept as an expression of freedom (Sen,

1999) to include economic, social and cultural dimensions, proxies for getting capabilities to meet collective needs. The interest in communication infrastructure through internet subscriptions at the regional level is an expression of the interest in measuring communication for development (Jacobson and Chang, 2019). Health capital, another component of index and typology measures, introduces another important family of capabilities to get appropriate means to reach what is valued as important for personal and collective life purposes.

The polarity of very poor to highly developed places/areas is underlined by using the conceptual pair of lagging versus leading regions, promoted here in the sense adopted by the World Bank (Grover, Lall, and Maloney, 2022). It seems, according to the previously mentioned study, that the economy of agglomeration, internal migration, and distance or digital connectivity are the key driving forces for the development of areas between the lagging and the leading places.

The complexity of working to the level of NUTS 3 for measuring human development is also complicated by the fact that the available data are rather poor. The great advantage of finding such data on the EUROSTAT platform is that one could increase to a continent-scale the comparability of NUTS 3 regions from the point of view of their human development.

2. Measuring Human Development at the NUTS 3 Level

An estimate of human development at the NUTS 2 level has already been proposed and convincingly argued as early as 2014 (Hardeman and Dijkstra, 2014). The proposed measure incorporated two indicators each for its three dimensions. Health status was measured using healthy life years expectancy and infant mortality rate, education was measured using the population aged 25-64 having completed tertiary education and the share of the population aged 18-24 neither in education nor in NEET (not in education, employment, or training) work, and economic development was measured using the share of those aged 15+ working, and an index of household income.

The relevant indicators were averaged using arithmetic means to construct measures of the dimensions and the resulting 3 indices were combined using geometric means to create the measure of the Human Development Index (HDI). All aggregations of variables were performed after standardization of the indicators using the min-max method.

To our knowledge, this is the first study promoting human development to the level of NUTS 3 in the European Union. These regions of NUTS 3 are more homogeneous than NUTS 2 and a measurement of their human development could largely contribute to a better understanding of territorial inequalities within the European Union.

In the case of the NUTS3 level Regional Human Development Index (RHDI) that we propose, we maintain the three measurement dimensions of the UNDP proposed approach, i.e. economic, health status and human/socio-human capital. The indicators used to measure these dimensions at the NUTS3 level for all EU countries are, however, dependent on public data supply (EUROSTAT).

Thus, we use the value of gross domestic product per capita, in comparable prices, as a percentage of the EU average, to estimate economic development. Socio-human capital was estimated by the share of households with broadband internet access via fibre optic connections (NGA, new generation access). For the estimation of health status,² we used a factor score aggregating the under-5 mortality, the overall mortality rate, and the standardised mortality ratio.

We adopted this composite measure of health status after experiencing the various forms with a geometric mean aggregating only the general mortality rate and the under-five mortality rate. The health measure including three indicators that were combined by the factor score allowed for an RHDI with a larger KMO index (.502).

The three estimates of economic capital, socio-human capital and health status were aggregated into the regional human development index as a factor score (KMO=.621), later converted to a Hull score, with variation between approximately 0 and 100) for ease of interpretation.

The methodological construction that we propose differs from the UNDP approach and the one proposed by Hardeman & Dijkstra (2014) in several respects (Figure 1). First, it differs in terms of the input indicators, which are conditioned by the available EUROSTAT data by type of territorial unit. Second, the method of aggregation also differs. We used a factor score for our calculation, in contrast to the geometric mean used in previous methods of computing the index.

Our use of the factor score limits the offsetting effects of the components of the human development index. In other words, we started from the premise that human development differs not only in intensity or degree, but also qualitatively, and typologically.

The practice of using principal component analysis to aggregate the three dimensions is also used by computing the multidimensional inclusiveness index (Dörffel and Schuhmann, 2022) by replacing conventional weightings with data-driven weighting. We will see, in the next section, to what extent the above methodological assumption is supported by the results of the analysis.

²*Life expectancy at birth would have been a powerful indicator for this dimension. Unfortunately, this indicator is not available from EUROSTAT at the NUTS 3 level. It is only available at NUTS 2 or national level.*

Figure 1. Comparing human development indices to three different levels

	Human development index (HDI) UNDP	RHDI NUTS2 (Hardeman&Dijkstra 2014)	RHDI NUTS3 proposed here
Measurement level	Nations (NUTS 0)	NUTS 2	NUTS3
Normalisation before aggregation of dimensions	min-max	min-max	not the case because principal component analysis normalise variables before aggregation
Dimensions and number of indicators	health - 1 indicator education - 2 indicators economy - 1 indicator	health 2 indicators knowledge 2 indicators income 2 indicators	health - 3 indicators, aggregated by factor score human capital - 1 indicator economic capital - 1 indicator
Aggregation method of dimensions	geometric mean (starting with 2010)	geometric mean	factor score
Normalisation after aggregation			Hull score

Source: Own study.

Example: The aggregation method of the dimensions is geometric mean for the human development index (HDI) starting with 2010 (and arithmetic mean before that), and, also for the Harman&Dijkstra (2014) construction of the regional human development index (RHDI). The method is more efficient than the arithmetic mean in limiting compensation effects among the components of indices. The factor score as an aggregation method in our construction of RHDI for NUTS3 is a data-driven one, allowing for compensation effects among the variables in the same factor or latent variable.

The typology of regions by their human development, as described in Table 1, differentiates between lagging regions at one extreme and leading regions at another extreme. In between there are other four classes of regions with very low health capital (high mortality rate), low connection capital, middle development, and upper middle development.

The RHDI and the human development typology of the regions are alternative measures that are considered to be valid if they can be predicted or are correlated with other external criteria. Are there significant associations between the type of the region by human development and country in the European Union? Are the countries that are specific for certain classes of human development neighbours of with similar cultures or histories?

Table 1. A typology of regional human development

Criteria of clustering (z scores)	Average values by cluster type						Total regions
	lagging regions	unhealthy	low connection capital	middle development	upper middle developed	leading regions	
regional human development	-2.83	-1.22	-0.81	0.03	0.87	2.34	
GDP per capita	-1.35	-1.05	-0.57	-0.17	0.70	3.01	
% subscriptions to internet	-2.60	-0.13	-1.31	0.27	0.57	1.11	
mortality index	2.73	1.64	0.06	0.00	-0.74	-0.87	
number of NUTS 3	29	110	196	470	307	40	1152
% NUTS 3	2.5	9.5	17.0	40.8	26.6	3.5	100.0

Source: EUROSTAT. Own computations. For example: the average value of the mortality index for the unhealthy NUTS 3 in the European Union is 1.64 (zscore variable, 2019). The classification is generated by a k-means cluster analysis in SPSS, using as input variables the constituent indices for RHDI and the RHDI per se, as z scores, in a randomised data file. The figures in the table, on the first four rows, indicate the average z values for each of the six classes. Unhealthy regions, for example, are identified by their very high average value of the mortality index. We marked by shadow the values that define a certain class.

Validating the index and the typology is done by their prediction, and function of several independent variables. Nine of them are measured as continuous variables and the tenth is a categorical one, referring to the EU country where the region is located. Before being used in multiple regressions, the quantitative variables are reduced to three basic dimensions, through a principal component analysis (Table 2).

The first-factor clusters predictors that are measured to NUTS 2 level, referring to regional competitiveness, percentage of youth of 15-29 years old that are neither in employment nor in education, net migration rate, and per cent of people with tertiary education out of the people of 15-64 years old.

Our methodological hypothesis is that regional human development is higher for NUTS 3 having higher competitiveness, density and vitality, as measured by NUTS 2 or NUTS 3 characteristics mentioned in Table 2. It is not only the regional competitiveness that counts but, also, other associated conditions such as NEET, migration attractiveness and a larger share of people with tertiary education. Higher density as population per square kilometre goes together with the urbanization degree and proximity to the country's capital. Demographic vitality is higher for regions with higher fertility rates and younger populations.

The methodological hypothesis is derived from a literature review, mainly from the World Bank's approaches to development. The theory of the three D stipulates that distance, density and disunity play an important role in the development of societies (Aoyama and Horner, 2009). More recent approaches of the World Bank focus on the role of agglomeration, mobility of people and economic distance in regional development (Grover *et al.*, 2022).

In line with these views, we hypothesised that regions of higher density, urbanization, immigration, education and vitality in demographic terms, could be more competitive. Some of these predictors could be highly correlated (age and education, for example). To avoid colinearity in regression analysis, we preferred to cluster previously these variables by factors or latent variables, following the logic of the data (Table 2).

Table 2. Data reduction of the predictors of regional human development

Variables	Measurement level	Component		
		Competitiveness	Density	Vitality
regional competitiveness index, basic, 2013	NUTS2	0,848	0,05	0,078
% youth neither in education, nor employment (NEET) 2018	NUTS2	-0,784	-0,008	-0,238
net migration rate 2018	NUTS2	0,67	0,112	-0,21
% tertiary education in 15-64 years old population, 2018,	NUTS2	0,554	0,225	0,483
population density 2019 (ln transformation)	NUTS3	0,255	0,824	-0,081
urbanization degree (1mainly urban, 2 intermediate, 3 mainly rural)	NUTS3	-0,155	-0,817	0,138
NUTS 3 including capital city	NUTS3	-0,046	0,598	0,158
total fertility rate 2017	NUTS3	0,173	-0,185	0,774
median age 2019	NUTS3	0,242	-0,506	-0,596

Source: EUROSTAT. Principal component analysis, Varimax with Kaiser normalisation. Figures in the table are loadings after rotation. KMO=0.577.

The hypothesis of competitiveness-density-vitality (CDV) that we support here is related but not identical to the hypothesis of the three D, density-distance-disunity of the World Bank (Aoyama and Horner, 2009). The three D hypothesis supports the view that being closer to high-concentration urban centres and with fewer obstacles brings development.

The CDV approach that we support considers also that a higher concentration of activities and people brings development. The regional approach we are interested in here could not measure the role of distance and borders or divisions among territorial units. It considers the role of competitiveness and vitality as characteristics of the reference unit that could bring development for the same unit.

The hypothesis on the role of CDV is, first of all, a methodological one. It has, also, a theoretical relevance supporting the view that regional human development has its

main roots in the three contexts of economic competitiveness, territorial density and population vitality. The probability of being more developed for NUTS 3 regions of the EU increases when there is higher economic competitiveness, density and vitality. Policies that are oriented to support these directions of change. Integrated development that goes beyond economic life (Senn 1999) on a regional level goes together with these three pillars of CDV.

What about the methodological problems of using principal component analysis to reduce the number of predictors in the regression analysis as in our case? The approach is not only allowed but it could contribute to avoiding colinearity among predictors that affects the regression results. Clustering highly associated predictors in the same factor or latent variable is a way to reduce the chances of collinearity. Shrestha (2021) advises the use of factor analysis to reduce the number of items in surveys and the series of predictors for dependent variables in regression analysis.

Both RHDI and the regional typology are constructed in the spirit of a relativistic approach, similar to the opposition between left-behind places (Pike et al. 2023) and prosperous ones. Sometimes, such a distinction underlines the moral responsibility or the intentionality of left-behindness. Several factors explain the history of such oppositions.

How much is involved in policy, agency or resources, is sometimes hard to identify by empirical data. This is why we prefer to talk about the opposition between lagging versus leading places (Ionescu-Heroiu *et al.*, 2013) where the subjective factors involved are to be determined by in-depth analysis. Interpreting what and why a certain place is left behind is easier to diagnose when one considers a limited number of places. When one talks, like here, on hundreds of regions is more appropriate to talk about lagging places or areas, contrasting them with leading regions/places.

3. Validation of RHDI by Country-Level Data

The analysis in Table 3 provides a first validation of the proposed typology of NUTS 3 regions from the perspective of poverty/development. The poorest regions, with relatively low values on all three constituent indicators of RHDI and the index per se, are mainly located in the former socialist countries that are the poorest in the EU, namely Bulgaria, Romania, and Croatia. The regions in these countries are, also, with NUTS 3 regions of very high mortality rates. Close to them are Hungary and, rather unexpectedly, Portugal, having very poor health capitals. It is unclear why Portugal, an OLD state of the EU, is in the category of a country with health problems.

The countries with low internet connectivity are located mainly in the South (Italy and Greece) and the grouping of former socialist countries (Poland, Slovakia and

Lithuania). The regions of middle development are mainly located in the Czech Republic, Slovenia, France and Espagne.

This first analysis by crossing the typology of RHD by country location of NUTS 3 regions gives a first validation of the classification that we proposed. The majority of regions that are in the lagging or unhealthy categories are in former poor socialist countries and the majority of the leading and upper-middle developed regions are parts of Nordic or Western old member states of the EU. Low connectivity regions are located in the South (Italy and Greece) and former socialist countries (Poland, Latvia, and Slovakia).

The findings are partly consistent with the analysis by Hardeman & Dijkstra (2014) on NUTS 2 level regions and show differences only in terms of degree but not type of development.

The level of socio-human development for some Eastern EU countries is, according to the data in Table 3, much lower than would be expected under their economic development. This is the case for Romania, Bulgaria and Croatia.

Upper-middle development regions that are mainly economically developed, are located in the grouping of OLD member states of the EU (Austria, Belgium, Netherlands, Finland, and Sweden). Ireland, Denmark and Germany define the category of leading countries.

An analysis (that is not shown here) that is also based on adjusted standardised residuals, as in Table 3, but with weighting by the NUTS 3 population, gives similar results. The lagging countries are, also, Bulgaria, Romania and Croatia (as in Table 3), but includes, also, Slovakia. The opposite class of leading regions, are, also located in Ireland, Germany and Denmark, as in Table 3.

Weighted data analysis brings, also, in this category, Belgium, Netherlands, and Sweden. The unweighted analysis is likely to be preferred because NUTS 3 are rather standardised territorial units in the EU, with a population between 150 thousand inhabitants to 800 thousand inhabitants and they are rather natural units where the cohesion and history count a lot, not only their administrative borders.

This analysis of the association between the typology of NUTS 3 regions and countries proves that the data are rather stable, not so much influenced by working with or without weighting by population for computing the adjusted standardised residuals. The results are similar if one passes from typological to index analysis as indicated by the map in Figure 2. The poorest regions, with minimal RHDI values, are Bulgaria, Romania and Croatia. The lower middle development regions are located, as expected, mainly in Eastern and Central European countries (Romania, Hungary, Slovakia and Poland).

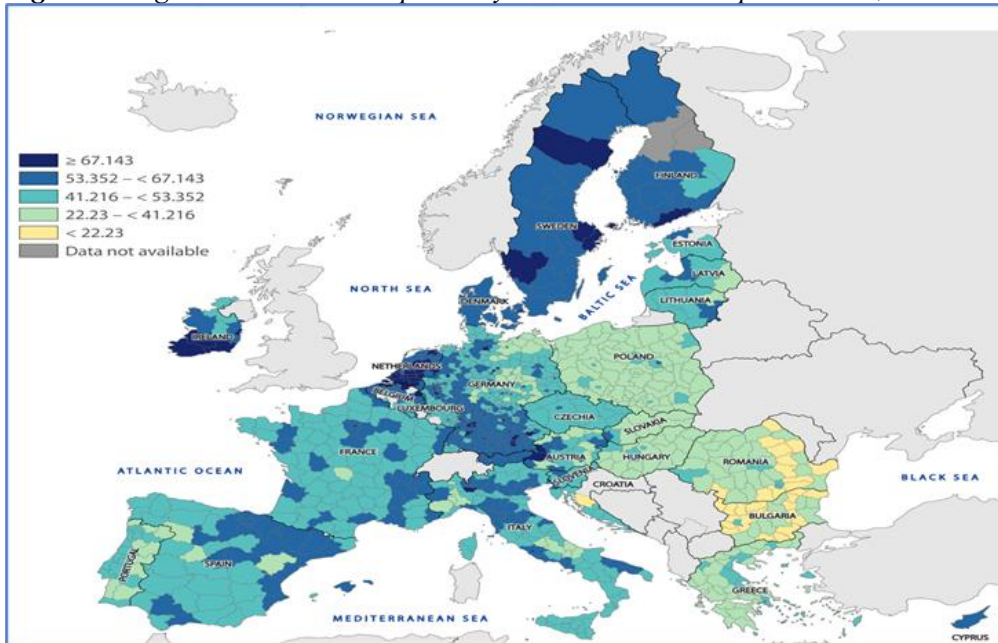
The most developed regions are in Sweden, Denmark, Finland, the Netherlands, Belgium, North of Italy, South of Ireland and North-East Spain.

Table 3. Percentages of NUTS 3 by country and type of human development, 2019 (%).

RHD type	Country	Type of regional human development (RHD)						Total
		lagging	unhealthy	low connectivity	middle development	upper middle	leading	
leading	IE	0.0	0.0	0.0	25.0	37.5	37.5	100
	DK	0.0	0.0	0.0	18.2	63.6	18.2	100
	DE	0.0	1.3	8.9	49.6	32.9	7.3	100
upper middle	SE	0.0	0.0	0.0	0.0	95.2	4.8	100
	NL	0.0	0.0	0.0	0.0	95.0	5.0	100
	FI	0.0	0.0	17.6	0.0	82.4	0.0	100
	BE	0.0	0.0	0.0	47.2	50.0	2.8	100
	AT	0.0	0.0	42.9	11.4	45.7	0.0	100
middle development	SI	0.0	8.3	0.0	83.3	8.3	0.0	100
	ES	0.0	0.0	20.3	61.0	18.6	0.0	100
	FR	0.0	3.0	0.0	78.2	16.8	2.0	100
	CZ	0.0	0.0	0.0	92.9	7.1	0.0	100
low connectivity	LT	0.0	0.0	70.0	30.0	0.0	0.0	100
	EL	0.0	11.5	69.2	17.3	1.9	0.0	100
	SK	12.5	25.0	50.0	0.0	12.5	0.0	100
	IT	0.0	0.0	29.1	48.2	22.7	0.0	100
	PL	0.0	27.4	58.9	12.3	1.4	0.0	100
unhealthy	PT	0.0	28.0	16.0	56.0	0.0	0.0	100
	HU	0.0	90.0	0.0	10.0	0.0	0.0	100
lagging and unhealthy	RO	28.6	64.3	2.4	4.8	0.0	0.0	100
	BG	50.0	46.4	0.0	3.6	0.0	0.0	100
	HR	9.5	38.1	14.3	38.1	0.0	0.0	100
	CY	0.0	0.0	0.0	0.0	100.0	0.0	100
	EE	0.0	0.0	0.0	80.0	20.0	0.0	100
	LV	0.0	0.0	16.7	66.7	16.7	0.0	100
	MT	0.0	0.0	0.0	100.0	0.0	0.0	100
	Total	2.5	9.5	17.0	40.8	26.6	3.5	100

Source: EUROSTAT. Own computations. The typology was constructed using cluster analysis, starting from the values of the three constitutive indicators of the RHDI (regional HDI), plus RHDI, using the k-means method for aggregation, and standardising all the four input indicators by z scores. The six classes of classification were interpreted by considering the percentage of NUTS 3 in each row. The clusters are mentioned in the columns of the table. The shadow indicates the cells where there is a significant positive association between the row and the column values, according to an adjusted standardised residuals analysis, that is not presented here. Example: 78.2% of the French NUTS 3 are in the category of middle development, in 2019, and the association between regional location in France and this category of regions is a positive, significant one.

Figure 2. Regional human development by NUTS3 in the European Union, 2019



Source: EUROSTAT. Own computation of the regional human development index (RHDI) to NUTS 3 level. Example: the poorest NUTS 3 are in Bulgaria, Romania and Croatia. The map is produced in interaction with IMAGE soft – GISCO, EC.

What if we consider the human development of NUTS 3 in a multivariate context as given by competitiveness, urbanization, vitality and national frames? This is what we will test in the next section.

4. Validating the Measurement of Regional Human Development by Multivariate Analysis

All three characteristics of NUTS 3 – competitiveness, density and vitality (CDV) – are significant predictors of regional human development. The higher their values, the higher the human development index (Table 4). If the dependent variable is the typology of regional human development, a categorical one, the results are consistent. Lagging regions, for example, are contextualised by lower values of competitiveness, density and vitality.

The opposite is true for leading regions where competitiveness, density and vitality are, also, higher. Unhealthy and low connectivity regions are, in a way, lagging regions but with specific facets, related to health and internet connectivity. Their context is also specified by lower values of CDV. On the contrary, NUTS 3 regions that are upper-middle from the point of view of their development have a context of higher values of CDV.

The same Table 4 specifies the impact of country location of the NUTS 3 for 16 EU countries. Higher probabilities for having lagging regions are for Bulgaria and Romania, two of the poorest countries of the EU. NUTS 3 regions from the same countries have a higher probability of being located there, plus, Hungary, another former socialist country of Europe.

Low connectivity regions are specific for Poland, Greece and Austria. The three countries were also in this category, in the bivariate analysis from Table 3. The leading regions are significantly located in Ireland, Germany and Denmark, three developed countries of the Old EU, as specified in the bivariate analysis in Table 3.

Table 4. Predicting regional human development by multinomial and OLS regressions

Predictors	Multinomial regression (reference category -NUTS 3 of middle development)										OLS regression	
	lagging regions		unhealthy regions		low connectivity		upper middle reg.		leading regions		Coefficient	
	Coeff.	P>z	Coeff.	P>z	Coeff.	P>z	Coeff.	P>z	Coeff.	P>z	Coeff.	P>t
Competitiveness	-3.748	0.000	-2.487	0.000	-0.755	0.001	1.865	0.000	1.821	0.004	4.112	0.000
Density	-8.043	0.000	-2.339	0.000	-2.082	0.000	1.615	0.000	3.165	0.000	5.949	0.000
Vitality	-1.137	0.010	-0.920	0.001	-0.851	0.000	1.131	0.000	1.536	0.000	1.976	0.000
IE	-21.065	1.000	-26.176	1.000	-26.664	1.000	2.075	0.112	8.797	0.000	22.488	0.000
DK	-11.456	1.000	-14.654	0.999	-16.227	0.998	2.779	0.002	6.118	0.010	8.024	0.000
DE	-13.721	0.994	1.207	0.130	0.339	0.371	1.070	0.003	5.798	0.000	3.016	0.000
SE	0.817	1.000	2.717	1.000	1.330	1.000	22.215	0.997	25.143	0.997	10.525	0.000
NL	9.855	0.999	5.479	0.999	2.632	1.000	20.730	0.996	23.185	0.996	9.083	0.000
FI	0.219	1.000	2.177	1.000	19.589	0.998	22.542	0.997	7.548	0.999	8.124	0.000
BE	-9.217	0.999	-14.231	0.998	-15.877	0.997	0.733	0.130	2.019	0.328	3.687	0.006
AT	-13.078	0.999	-14.890	0.998	3.382	0.000	4.063	0.000	-13.958	0.999	2.846	0.043
EL	-15.450	0.999	3.391	0.000	4.251	0.000	-3.638	0.004	-22.167	0.999	-9.120	0.000
SK	28.115	0.998	22.479	0.999	23.325	0.999	3.891	1.000	8.731	1.000	-12.099	0.000
IT	-17.332	0.996	-20.294	0.994	0.445	0.416	4.658	0.000	-9.088	0.998	6.675	0.000
PL	-9.700	0.999	5.593	0.000	5.936	0.000	-4.042	0.045	-19.946	0.997	-12.811	0.000
PT	-19.937	0.999	0.467	0.534	-0.518	0.491	-18.811	0.997	-18.631	0.999	-0.409	0.805
HU	-17.831	1.000	6.234	0.000	-20.738	1.000	-24.880	1.000	-23.163	1.000	-10.261	0.000
RO	6.002	0.011	4.721	0.017	3.495	0.095	-30.703	1.000	-28.738	1.000	-12.635	0.000
BG	12.029	0.003	7.887	0.040	-32.967	1.000	-34.563	1.000	-32.917	1.000	-26.299	0.000
_cons	-13.343	0.000	-4.832	0.000	-3.096	0.000	-2.862	0.000	-10.261	0.000	49.791	0.000
Pseudo R2 or R2	0.526											
N	1104											

Source: EUROSTAT. Own computations. Countries having the majority of NUTS 3 in the middle development category are not included as predictors to avoid multicollinearity effects. For the same reason, we did not consider small countries (Croatia, Latvia, Estonia, Lithuania, and Cyprus). OLS regression in the last column of the table has RHDI as a dependent variable. Multinomial regression has as a dependent variable the typology of the human development-poverty for the region.

5. Discussion and Conclusions

The analysis demonstrates that the proposed regional human development index and the typology are valid measures, leading to interpretable results, to meaningful multiple comparisons between NUTS 3 regions in different EU countries. This multivariate validation supports the idea that both of the tools – the index and the typology, are reliable tools to be used for research and application purposes.

This kind of regional analysis on RHDI and the complementary typology has several advantages. It is of course advantageous to be able to identify the likelihood of finding or not finding lagging or leading areas in one EU country or another. If, however, the analysis is carried out at the local level (LAU - municipality, town, city, commune, etc.) then there is the obstacle of the diversity of situations.

Although NUTS 3 regions are more homogeneous than NUTS 2 regions, they are still heterogeneous. Consequently, the need to develop a separate methodology for identifying poverty/development at the local level remains valid. The challenge of having different data for measuring human development at the local level, in different countries, could be met by keeping, for comparability, the same dimensions of analysis for all the countries, but operationalising the reference dimensions differently, function of available data. The dimensions could be material, health and communication capital.

A supplementary advantage of measuring the human development for NUTS3 is that this is also a way to measure the average human development for NUTS2. One could use NUTS3 population as a weighting variable and compute the medium level of NUTS2, starting from RHDI for the component NUTS3. Intraregional disparities of NUTS2 development could be measured by considering RHDI for NUTS3.

The RHDI and the typology of regional human development of NUTS3 bring, also, to the reader, theoretical aspects by their validation. The analysis clearly shows that regional development is rooted in its competitiveness, density and vitality contexts. All three dimensions are necessary to predict and explain regional human development.

The higher density of the population seems to be more important than competitiveness and vitality in the prediction of regional human development. A good specification of the analysis models obliges not only to consider the three types of contexts but also to include in the analysis the country context. By specifying contexts, types and levels of development, this approach could favour place-sensitive policies for development (Iammarino et al. 2019).

Of course, the proposed index can be improved. Estimating health capital in the region, through life expectancy at birth, for example, is still desirable. As such data

exist at the EUROSTAT level for NUTS 2, they could, with further efforts, be provided for NUTS 3, too.

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