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EXTENDED ABSTRACT

Title:

DL2 method for assessing the socio-economic vulnerability of the EU regions

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1. Context

The EU Cohesion Policy for the 2021-2027 Multiannual Financial Framework aims at fostering a modernised regional development and cohesion policy focusing on five political goals so that the EU becomes: (1) smarter, through innovation and digitisation, (2) greener, (3) more connected, (4) more social and (5) closer to citizens (European Commission, 2018). The EU will dedicate 34% of its budget over 2021-2027 to cohesion and values, that represents the highest amount of commitment appropriations (European Commission, 2020a).

These guidelines mean that EU opts for the increasingly accepted mainstream, stressing that GDP is insufficient to assess the progress of society, and the measurement of regional development has to struggle with the multidimensional nature of well-being (O'Donnell et al., 2014; Stiglitz et al., 2018). Nevertheless, a single macroeconomic index is again proposed as the predominant criterion for allocating the Structural Funds among the regions in 2021-2027.

2. Objective

In this paper, we hypothesise that new complementary criteria could be taken into account in line with the five goals of EU Cohesion Policy outlined above in order to better reflect the reality on the ground of the regions. Our objective is to build a composite indicator to study the socio-economic vulnerability of the EU regions in terms of the 2021-2027 Cohesion Policy.

3. Concept of socio-economic vulnerability

As a first definition, vulnerability refers to the predisposition to be adversely affected together with the difficulty of reacting. We focus on the most recent vulnerability studies that encompass two domains: fragility to suffer harm, and the capacity to cope and adapt or resilience (Halkos et al., 2020; Marulanda Fraume et al., 2020).

Under this framework, socio-economic regional fragility refers to the predisposition to suffer harm from the disadvantageous conditions and relative weaknesses related to social and economic factors. On the other hand, resilience is the ability to face shocks and persistent structural changes (e.g. digital transformation, globalisation and climate change) that affect people and society in such a way that current societal well-being is preserved (Alessi et al., 2020; Benczur et. al., 2020). In the context of the COVID-19 crisis, the *2020 Strategic Foresight Report* (European Commission, 2020b) identifies groups of people and areas that have suffered the effects of the pandemic most and face greater difficulties in coping with their effects. Likewise, this Report highlights the key points to enhance resilience against COVID-19.

Consequently, in the context of the EU 2021-2027 Cohesion Policy, the degree of a region's socio-economic vulnerability might be estimated by a composite indicator built from a system of single indicators able to take into account these policy goals. Within this setting, the situation of a region with a greater degree of socio-economic vulnerability might be understood as having greater obstacles to achieve the Cohesion Policy goals (2021-2027).

All in all, our proposal is that the socio-economic vulnerability of a region is a latent variable, since it is a concept which cannot be measured or estimated directly. Likewise, vulnerability is a multidimensional construct that can be assessed using collectable social and economic indicators.

4. Data and methodology

To assess the socioeconomic vulnerability of the EU regions, we use the official statistics of EUROSTAT and OECD at the NUTS-2 level, working with the most recent regional territorial classification (NUTS 2016). The overseas NUTS-2 territories have not been taken into account, so the final number of regions is 233 from all the 27 Member States. We develop a system of single indicators of 16 indicators: eight indicators representing regional fragility and eight indicators representing resilience. Table 1 presents the descriptive statistics for the 16 indicators, differentiating between fragility and resilience indicators. The indicators are calculated as the mean of the registered values in 2016 a 2017.

To build the Socio Economic Vulnerability Index of the EU regions (SEVI), we rely on the DL2 method which is based on the mathematical concept of distance or metric (see Fernández-Jiménez et al., 2022). More specifically, the SEVI represents a weighted Euclidean metric that is defined as follows:

$$\mathrm{SEVI}_i = \left(\sum_{j=1}^{m} \left| x_{ij} - x_{*j} \right|^2 w_j\right)^{1/2} \quad (1)$$

where m is the number of single indicators, x_{ij} is the value of the j-th indicator in the i-th region, x_{*j} is the j-th value in the reference vector $X_* = (x_{*1}, x_{*2},...,x_{*m})$ and w_j is the weight of the j-th single indicator.

The reference vector (X_*) is a hypothetical region that, in the set of all EU regions, registers the best values of all single indicators. Thus, we take into account the complete empirical distribution in the 233 EU regions. The idea is that the higher the value of SEVI, the greater the difficulty in achieving these objectives compared to the rest of the regions.

The weights of the single indicators (wj) are computed using unsupervised machine learning algorithms. We apply multivariate adaptative regression splines (MARS) to identify the best functional relationships between the composite indicator and the set of single indicators. By doing this, the potential redundant information among the indicators is avoided.

Table 1

Descriptive statistics of socio-economic vulnerability indicators for the EU27 regions in 2016-2017 (N = 233 NUTS-2)

Fragility indicators	**Mean**	**SD**	**Min**	**Max**	**CV**	**Region baseline**
Early leavers	10.21	4.87	1.35	27.35	47.72	HR03 - Jadranska Hrvatska
PM2.5	12.89	4.27	4.40	28.28	33.16	PT20 - Região Autónoma Açores
Elderly people	9.48	2.11	4.57	15.52	22.28	NL23 - Flevoland
Male unemployment	7.94	4.80	1.85	24.15	60.52	CZ01 - Praha
Female unemployment	8.78	6.95	1.90	39.25	79.22	DE22 - Niederbayern
Youth unemployment	20.39	12.89	3.60	57.15	63.21	DE93 - Lüneburg
Migrant	3.23	4.36	0	38.80	134.91	Regions with negative rate
Assault & crime	0.74	0.52	0.08	4.24	70.61	FRC2 - Franche-Comté
Resilience indicators	**Mean**	**SD**	**Min**	**Max**	**CV**	**Region baseline**
R&D business	0.98	0.96	0	8.06	97.31	DE91 - Braunschweig
R&D state	0.61	0.44	0	2.52	71.31	DEB2 - Trier
Tertiary education	29.12	9.00	11.80	55.00	30.89	PL91 - Warszawski stoleczny
Human resources in technology	31.92	8.38	13.95	54.70	26.24	PL91 - Warszawski stoleczny
Registered community designs	3,591.21	4,000.26	0	24,813.07	111.39	ITH4 - Friuli-Venezia Giulia
Internet	97.33	2.69	87.50	100.00	2.77	Several regions with 100
E-Administration	51.42	20.09	4.50	92.00	39.08	DK01 - Hovedstaden
GDP-Gini	19,782.30	7,905.24	5,459.60	52,512.45	39.96	LU00 - Luxembourg

Note. HR is Croatia, PT Portugal, NL Netherlands, CZ Czech Republic, DE Germany, FR France, PL Poland, IT Italy, DK Denmark, LU Luxemburg.

5. Results and conclusions

Figure 1 shows the weights assigned to each indicator; specifically, the proportion in which each indicator contributed to the metric and therefore to the SEVI.

By implementing the SEVI as an allocation mechanism of the Structural Funds rather than GDP per capita as proposed by the EU, and with an equivalent budgetary effort in terms of the benefited population, we obtain the results illustrated in Figure 2. Our main findings are that, according of the SEVI, a large number of regions in Italy and Spain and some in Portugal, France and Greece should be in the group of the most benefited regions from the Structural Funds in spite they exceed the limit in terms of GDP per capita. On the contrary, regions in Member States of the previous eastern Europe, which are historically characterised by low levels of GDP per capita, register lower relative positions in the SEVI.

These outstanding differences in the maps of priority regions should be discussed in order to introduce new game rules for the EU Cohesion Policy, especially in the current context of post-COVID-19 where public policies should prioritise improving citizens' well-being.

Figure 1

Weights of the single indicators of SEVI

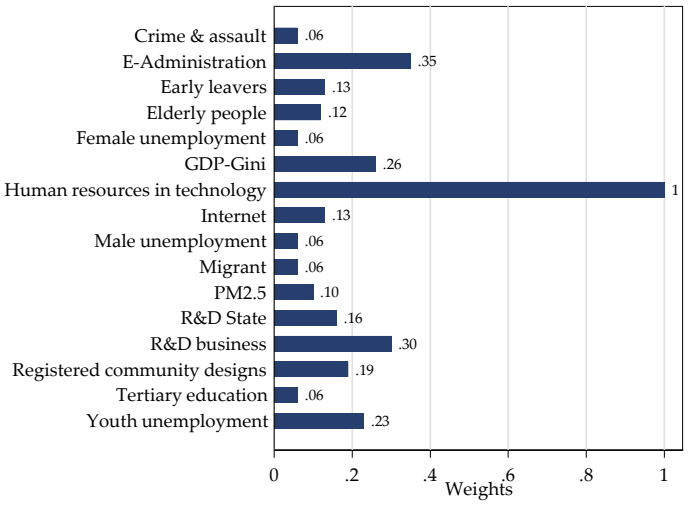
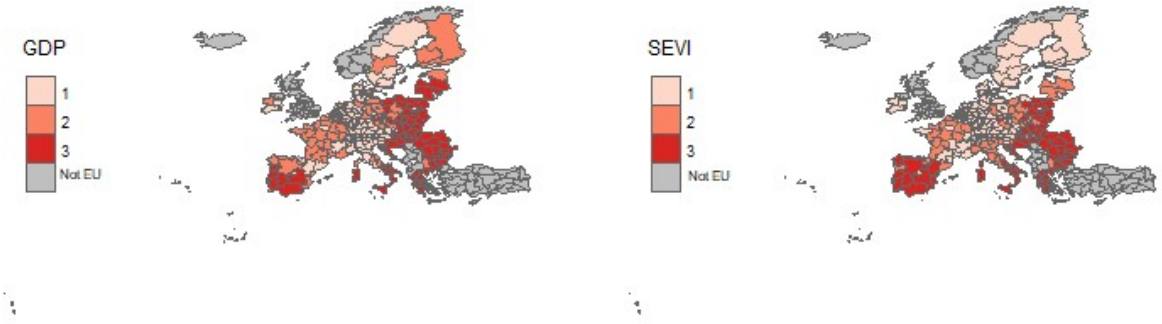


Figure 2

Classification of EU regions according GDP per capita and socio-economic vulnerability



Note. According GDP per capita: group 1 (47% of population residing in regions with GDP per capita above the GDP per capita of the whole of EU), group 2 (25 % of population residing in regions with GDP per capita between 75% and 100% of the UE27), group 3 (28 % of population residing in regions with GDP per capita below the 75% of the UE27). According the SEVI, regions are classified into three groups from less to higher socio-economic vulnerability with the next percentages of population: group 1 (46.35%), group 2 (26.40%) and group 3 (27.25%).

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