PAPER

Title: *Regional inequality, spatial dependence, and proximity structures: an application to EU regions*

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Abstract

Since some decades, inequality is attracting a growing interest within the political debate as well as in theoretical and empirical studies. Considering inequality at regional level offers useful insights for policy makers, facilitating the assessment of the effectiveness of strategies aimed at reducing regional disparities and helping in developing place-based actions. The study of regional inequality poses some relevant issues related to the spatial nature of data. In fact, dealing with georeferenced data implies the opportunity of considering the spatial interactions among regional units that are likely to play a role in shaping the inequality dynamics. Some studies highlighted the importance of incorporating spatial effects in a traditional measure of inequality such as the Gini index. These studies are based on the definition of a proximity structure, that allows one to discriminate between the spatial and the non-spatial component of inequality. Different definitions of the proximity structure are likely to influence the spatial component of inequality. Those aspects are analysed in the present paper to offer more detailed insight in the territorial dimension of inequality. The measures and their decompositions are discussed in the case of European NUTS 3 regions.

Keywords: Economic disparities, spatial effects, neighbour regions, NUTS 3.

Regional inequality, spatial dependence, and proximity structure: an application to EU regions

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Inequality is attracting interest in the political debate but also in empirical and in theoretical scientific literature. Indeed, inequality at regional level offers useful insights for policy makers, and it improves the effectiveness of strategies for reducing regional disparities and activating place-based actions. However, regional inequality poses some relevant issues related to the spatial nature of data. In fact, dealing with spatially referenced data implies the opportunity of considering the spatial interactions among regional units that are likely to play a role in shaping the inequality dynamics.

Some studies highlighted the importance of incorporating spatial effects in a traditional measure of inequality such as the Gini index, which are based on the definition of a proximity structure, that allows one to discriminate between the spatial and the non-spatial inequality. Further, different proximity structures are likely to influence the spatial component of inequality and lead to different results.

By the introduction of cohesion as a paradigm of the European Community, the EU regional policies ground on a broad idea of cohesion, including social and territorial dimensions. Since specific features of a locality are crucial factors to promote or impede its growth and success, accounting for specificities of territories implies rethinking policy interventions, putting aside "on-size-fits-all" policies in favour of differentiated

development strategies (Barca et al. 2012; Artelaris and Petrakos, 2016). However, if on the one hand absolute location of a regional unit is likely to impact on its economy, on the other side a relevant role is also played by its relative location (i.e., the influence of its neighbourhood).

Recent literature has been proposed in this direction. For example, Rey and Smith (2013), Márquez et al. (2019), and Panzera and Postiglione (2020) focused on the relevance of spatial effects while discussing the economic and social disparities, as the territorial dimension is more seen as critical for tackling inequalities (Márquez et al. 2019).

Another issue involves linkages, connections, and spatial relationships, which are pivotal to the measurement of neighbourhood effects. The definition of the proximity structures (i.e., **W**) reflects specific hypotheses about the strength of regional interconnections and the spillover mechanisms. Still, the identification of imposed exogenous spatial relationships has been seen as critical (Corrado and Fingleton, 2012) and the impacts of different definitions of **W** are sometimes subordinated in the practice to other problems.

Following these considerations, in this paper we aim at measuring inequality at NUTS 3 level in the EU, while considering the impacts of regional interconnections using different definitions of proximity matrices. To give wider evidence, we focus on a fine spatial scale as the NUTS 3 level in the EU. Larger attention on the role of the spatial dependence in the analysis of regional inequality in the EU is presented focusing on the consequences of spatial dependence in the traditional inequality measures.

An approach to the decomposition of the Gini index has been proposed by Panzera and Postiglione (2020). This approach relies on the covariance-based formula of the Gini index, and on its decomposition in a spatial Gini index (G_S), and a non-spatial Gini, (G_{ns}) as:

$$G = \frac{Cov(x, R_x/N)}{\mu_x} = G_S + G_{ns} \qquad (1)$$

where R_x is the rank assigned to the regional GDP value (such that $R_x = 1$ for the lowest value of regional GDP per capita and $R_x = N$ for the highest value) and all the other quantities are defined as above.

The spatial Gini index G_S is obtained by reranking the GDP values according to the rank assigned to the average GDP observed for neighbouring regions (R_{Wx}) and by considering the correlation between the regional GDP per capita and this new rank as:

$$G_S = \frac{2Cov(x, R_{Wx}/N)}{\mu_x} \qquad (2).$$

The spatial Gini index in (2) expresses the component of inequality that is determined by the spatial dependence effect. Since this component is obtained by a reranking of GDP values, it varies between $-G$ and G (Panzera and Postiglione, 2020).

Table 1: Spatial (G_s) and non-spatial (G_{ns}) components of the Gini index calculated for GDP per worker, 1322 NUTS 3 EU regions, 2001-2019. Economic distance base.

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
G_s	0.0798	0.0802	0.0808	0.0786	0.0796	0.0783	0.0769	0.0724	0.0707	0.0729
G_{ns}	0.0950	0.0893	0.0844	0.0818	0.0806	0.0801	0.0802	0.0786	0.0772	0.0746
I	0.2375	0.2476	0.2079	0.2616	0.2381	0.1998	0.2315	0.1829	0.1879	0.2375
Year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	
G_s	0.0720	0.0701	0.0697	0.0713	0.0706	0.0701	0.0692	0.0669	0.0643	
G_{ns}	0.0733	0.0720	0.0707	0.0681	0.0707	0.0706	0.0698	0.0699	0.0700	
I	0.2375	0.2476	0.2079	0.2616	0.2381	0.1998	0.2315	0.1829	0.1879	

The evidence shows how discarding the spatial interactions among neighbouring regional units result in a considerable loss of details. Analyst and European policy makers should consider not only the overall level of inequality, but also isolate specific component of inequality to take action in critical situations. Particularly, the effects due to geographical position of the data retrieve additional information on significative geographical patterns.

Further, two methodological approaches are tested for different **W** matrices, including the economic distance (Table 1). By comparing the different spatial configurations, the empirical analysis highlights the dominance of the spatial component on the idiosyncratic component, where a geographical component is used. Research in terms of spatial indicators of inequalities could be further addressed in future studies, also extending inferential properties of those methodologies, and considering other proximity matrices that include other economic phenomena or a combination of those.

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