How does space affect the distribution of the EU RDP funds? An econometric assessment

Camaioni B.[2], Esposti R. [1], Lobianco A.[1], Pagliacci F. [1], Sotte F. [1],

[1] Università Politecnica delle Marche, Dept. of Economics and Social Sciences, Ancona, Italy
[2] INEA, Italy

f.pagliacci@univpm.it

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Summary

This paper aims at investigating the main drivers of the distribution of the RDP funds across the EU space. Eventually, fund allocation is the consequence of some political decision. Nonetheless, this political decision can not be directly observed. While the allocation across countries and, when present, across NUTS2 regions is explicitly decided ex-ante, the allocation at a lower territorial level can only be observed ex-post. This "local" allocation depends not only on the top-down decision taken at some national or local political level but also on the bottom-up (or local) capacity to attract and use these funds. To investigate this more "local" level, funds' distribution across 1,300 EU NUTS3 regions is considered. Three different effects are admitted as major drivers of this spatial allocation. The "country effect" takes into account the well known differentials in the size and intensity of support across EU countries. The "rural effect" captures the fact that, at least in principle, the more rural a region is the larger the amount of RDP support it is expected to receive. However, this effect may vary according to alternative definition of rurality, The last effect is the "pure spatial effect" and expresses the influence, on the support received by a region, of the bordering regions and, in particular, of their degree of rurality. These effects are estimated adopting alternative spatial model specifications: the spatial Durbin model, the SEM and the SAR model. Though results differ across these alternative specifications, they are concordant in suggesting that in fund allocation rurality matters but in a counterintuitive direction, while also the neighbouring regions play a role.

Keywords: spatial econometrics, EU rural development policy, rurality indicators

JEL Classification codes: R58, Q01, O18

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Camaioni B.[2], Esposti R.[1], Lobianco A.[1], Pagliacci F.[1], Sotte F.[1]

[1] Università Politecnica delle Marche, Dept. of Economics and Social Sciences, Ancona, Italy
[2] INEA, Italy

1. INTRODUCTION

This paper is aimed at stressing the relevance of the geographical issues in defining the allocation of the Rural Development Policy (RDP) expenditures. Eventually, fund allocation is the consequence of some political decision. Nonetheless, this political decision can not be directly observed. While the allocation across countries and, when present, across NUTS 2 regions is explicitly decided ex-ante, the allocation at a lower territorial level can only be observed ex-post. This "local" allocation depends not only on the top-down decision taken at some national or local political level but also on the bottom-up (or local) capacity to attract and use these funds. The present paper aims at investigating fund allocation considering the actual *ex post* expenditure at this more "local" level, by analysing funds' distribution across 1,300 EU NUTS 3 regions.[1]

Different effects are here considered as major drivers of this spatial allocation. First, a *country effect* can be observed: each EU Member State shows different intensities of RDP expenditure as effect of the well known differentials in the rural support across EU countries. Then, a specific *rural effect* is expected to capture the fact that, at least in principle, the more rural a given region is the larger is the amount of RDP support it is expected to receive. However, this effect may vary according to alternative definitions of rurality. Finally, a *pure spatial effect* is also considered. This effect captures the idea that the amount of support received by a given region can be also influenced by the amount of support received by the neighbouring regions and, consequently, by their degree of rurality.

Working at the maximum disaggregated territorial level (NUTS 3), adopting alternative and more comprehensive definitions of rurality, explicitly modelling spatial dependence, represent the main original aspects of the present study. Evidently, the research objective is not new. Previous studies already investigated the territorial allocation of the EU RDP funds (Shucksmith et al., 2005). However, in none of them fund allocation is analysed at the NUTS 3 level and looking at the real expenditure. Moreover, they associate funds' distribution to the degree of rurality expressed only by conventional indicators and often exclusively relying on the OECD-Eurostat urban-rural typologies.

According to this general framework, the present paper analyses the spatial allocation of the RDP funds by estimating the above-mentioned effects throughout the specification of a sequence of econometric models: moving from a generic OLS model to models where spatial dependence (or correlation) is made explicit in different forms.

The work is organised as follows. Section 2 provides some detailed information on RDP expenditure data. Moreover, some alternative measures of rurality are suggested, in order to properly assess the rural effect. Section 3 describes the econometric models: i) the generic *OLS model* that does not take into account any spatial effect; ii) the *spatial Durbin model*, that accounts for the spatially-lagged independent variable (in particular, the rural effect); iii) the *SEM* (Spatial Error Model); iii) the *SAR* (Spatial AutoRegressive) *model*.

[1] NUTS is an acronym indicating the *Nomenclature of territorial units for statistics*.

Section 4 illustrates and discusses the main estimation results. Section 5 concludes the paper, by suggesting some policy implication of the analysis together with possible direction of future research in this field.

2. DATA

2.1. RDP expenditure

The Rural Development Policy (RDP) is the second pillar of the Common Agricultural Policy (CAP). This policy is financed by the European Agricultural Fund for Rural Development (EAFRD) and is aimed at supporting rural areas, which still represent a vital part of the EU economy and society. In spite of some major weaknesses, those regions have been facing new opportunities and challenges within the progressive transformation of the developed industrial economies (the 'post-industrial rurality') (Sotte, 2009; Esposti, 2011; Sotte *et al.*, 2012). In the 2007-2013 programming period, RDP aims at: i) improving the competitiveness of the agricultural and forestry sector (economic restructuring of rural areas); ii) enhancing the sustainable management of natural resources and helping regions in meeting future economic and environmental challenges; iii) improving the quality of life in rural areas (throughout the increasing diversification of the rural economies).

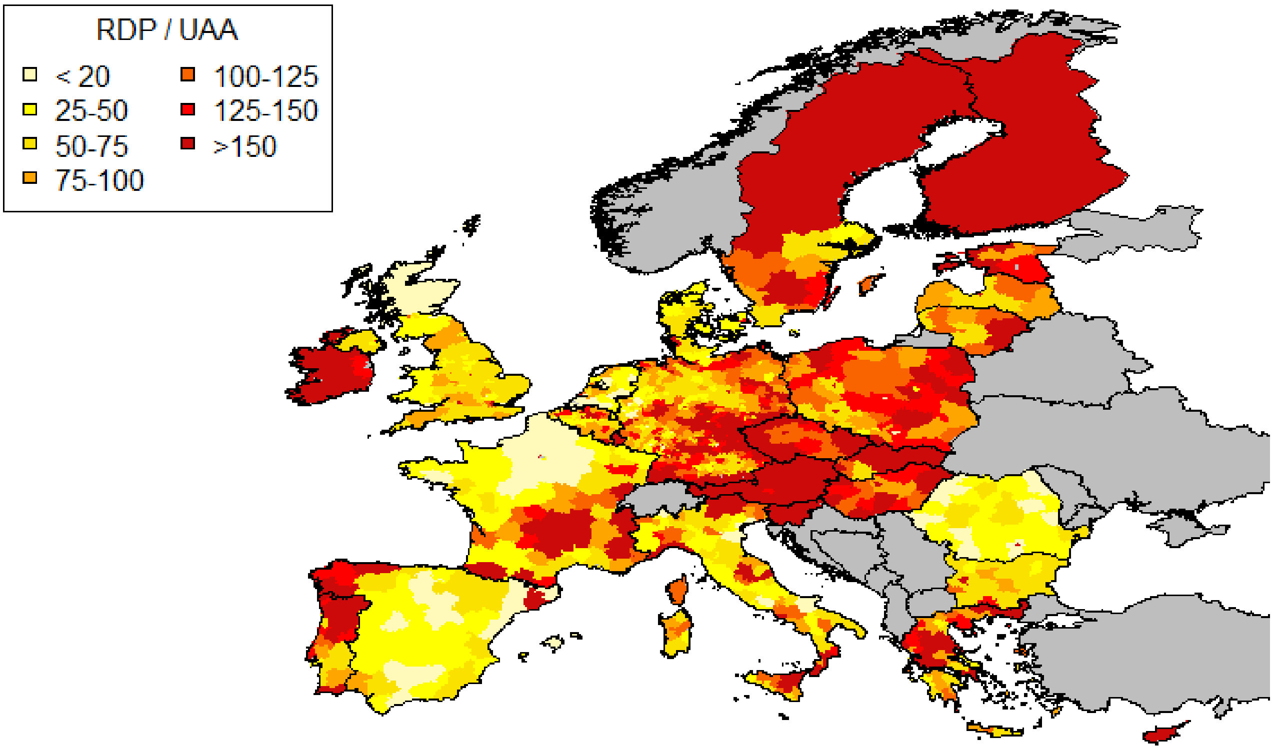
Depending on these generic objectives, EAFRD expenditures do not show an homogenous spatial allocation. Here, data on total EAFRD actual expenditure have been collected at the NUTS 3 level according to the NUTS 2006 classification (about 1,300 regions) for years 2007 to 2009. By themselves, these expenditure data do not allow directly representing the different support across regions due to their largely different size. Therefore, the analysis on fund allocation is here performed by means of three indexes expressing the expenditure intensity:

1. RDP expenditure per unit of Utilized Agricultural Area in ha (€/UAA);
2. RDP expenditure per agricultural Annual Working Unit (€/AWU);
3. RDP expenditure per thousand Euros of agricultural Gross Value Added (€/.000 €).

Data on utilized agricultural areas (UAA) and annual work units (AWU) are collected from the Eurostat Farm Structure Survey (2007). Data on agricultural GVA are taken from Eurostat National Accounts (the average value for years 2007 to 2010 is considered).

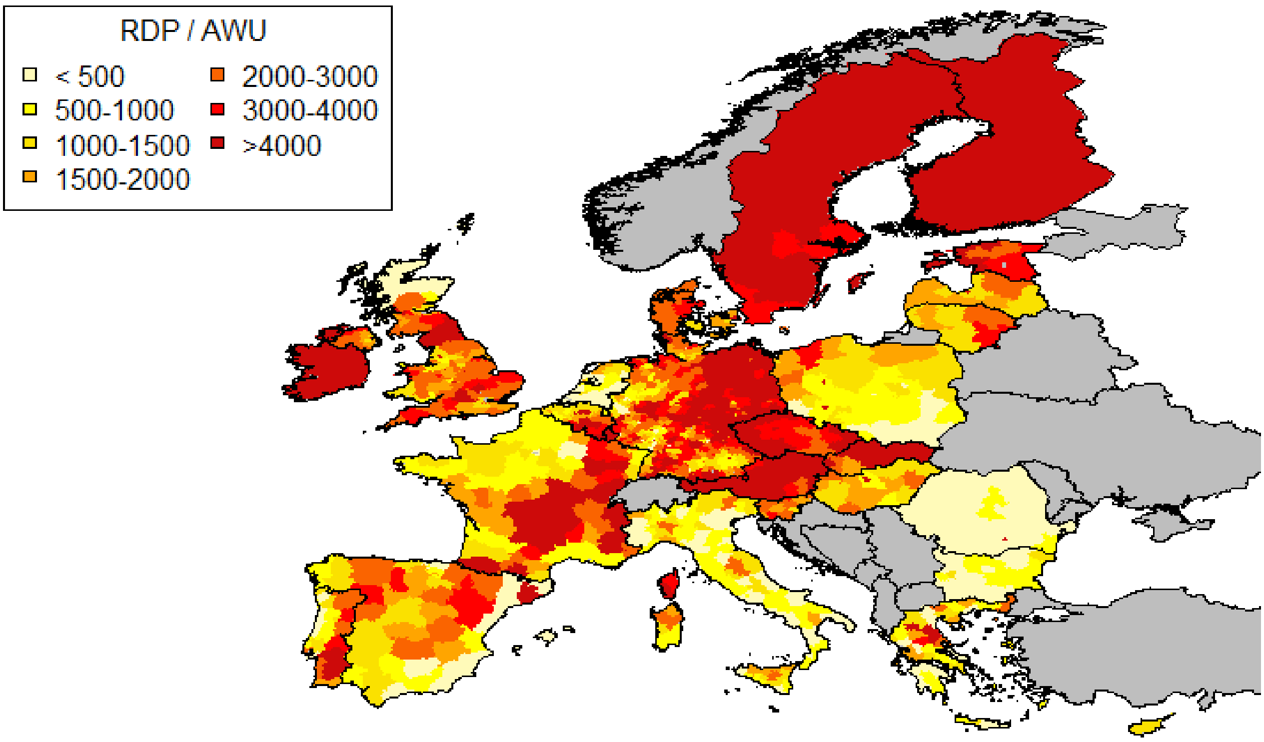
These indexes confirm the heterogeneous spatial allocation of the RDP expenditures (Figure 1, Figure 2 and Figure 3). The emerging territorial distribution can be attributed to some major differences across EU regions and, in particular, land use characteristics (e.g., the presence of woodlands and forests) and sector-based characteristics (e.g., the relevance of the agricultural sector within the local economy), but it also evidently depends on geographical characteristics, that is, the country they belong to and the surrounding regions. The combination of all these factors, however, generates a complex picture. For instance, the RDP expenditure intensity per unit of UAA is particularly low in both the plain regions of Northern France and of Spain. Conversely, the RDP expenditure intensity per agricultural GVA (in thousand €) is particularly high in the regions of Eastern European Countries due to their lower agricultural GVA values.

Figure 1 - 2007-2009 RDP expenditure per unit of Utilized Agricultural Area (€/UAA)



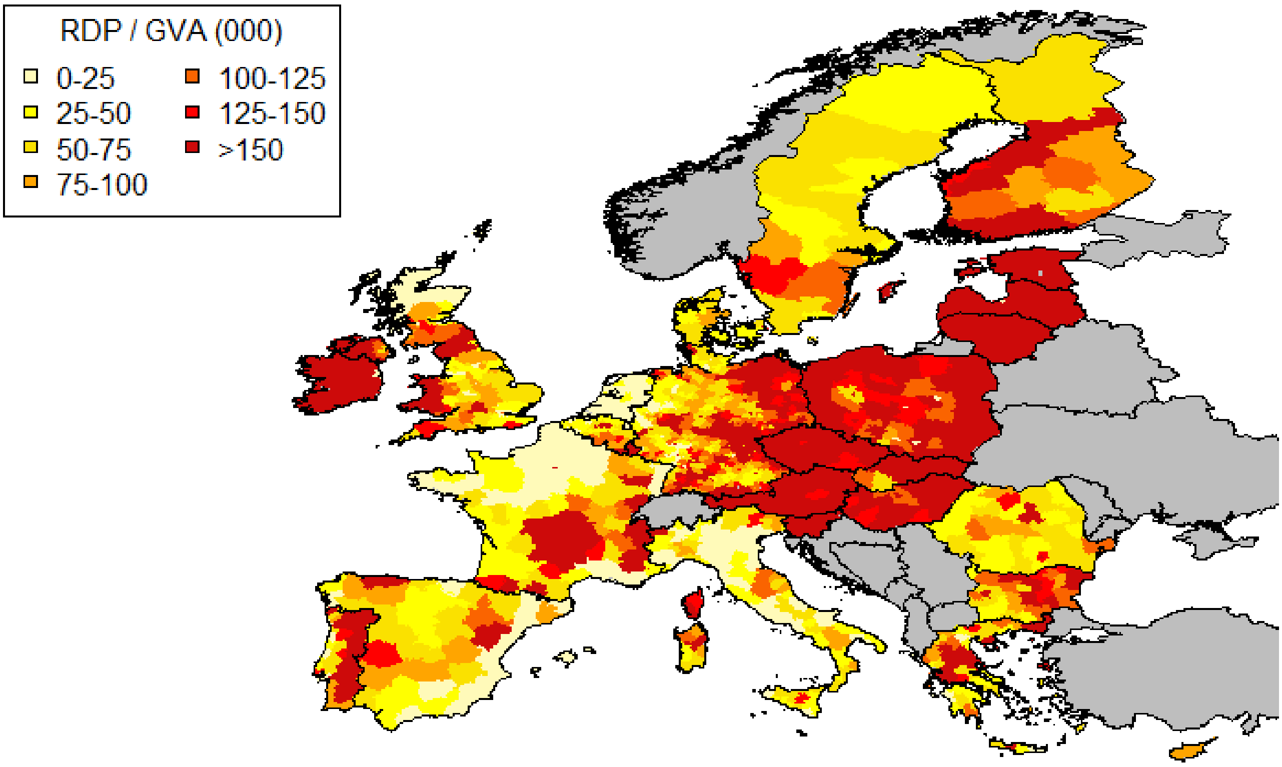
Source: authors' elaboration

Figure 2 - 2007-2009 RDP expenditure per agricultural Annual Working Unit (€/AWU)



Source: authors' elaboration

Figure 3 - 2007-2009 RDP expenditure per unit of agricultural Gross Value Added (€/.000 €)



Source: authors' elaboration

Analysing in detail the RDP expenditure intensity at the NUTS 3 level, some outliers can be detected: they mainly refer to urban areas, where UAA and AWU are quite small but expenditure is still significant as several RDP beneficiaries are located in these regions. This implies "artificially" high levels of expenditure intensity. Thus, according to the distribution of these indexes, the following outliers have been dropped out from the dataset:

- RDP expenditure per UAA: Berlin (DE300); Riga (LV006); Dublin (IE021); Byen København (DK011); Potsdam Kreisfreie Stadt (DE423); Miasto Poznan (PL415); Inner London West (UKI11); Inner London East (UKI12); Bruxelles (BE100); Portsmouth (UKJ31); Coburg Kreisfreie Stadt (DE243); Budapest (HU101); Wien (AT130); Paris (FR101); Bucaresti (RO321);
- RDP expenditures per agricultural AWU: Riga (LV006); Byen København (DK011); Potsdam Kreisfreie Stadt (DE423); Inner London West (UKI11); Inner London East (UKI12); Bruxelles (BE100); Paris (FR101); Luton (UKH21); City of Edinburgh (UKM25); Blackburn with Darwen (UKD41); Milton Keynes (UKJ12); Schweinfurt Kreisfreie Stadt (DE262); Isle of Wight (UKJ34); Brighton and Hove (UKJ21); Swindon (UKK14); Wismar Kreisfreie Stadt (DE806); Plymouth (UKK41);
- RDP expenditures per agricultural GVA: Wismar Kreisfreie Stadt (DE806); Potsdam Kreisfreie Stadt (DE423); Bruxelles (BE100); Paris (FR101).

After excluding these outliers from the dataset, the numerosity of the sample under investigation becomes of 1288 NUTS 3 regions.

2.2. Alternative measures to define rurality

In principle, among the factors that influence the spatial allocation of RDP expenditure among regions, their degree of rurality should be the prominent one (we call it the "rural effect"). However, the relevance of this factor may vary according to alternative definitions of rurality. A wide literature has focused on this topic in the last two decades, but homogeneous and univocal definitions distinguishing rural regions from urban ones are still lacking at the international level (Montresor, 2002; Anania and Tenuta, 2008). For example, the EC does not provide any formal criterion to identify those areas where rural development policies are expected to be implemented: each Member State (or NUTS 2 region) is autonomously in charge of defining its own rural areas. This is justified by the fact that wide differences in terms of demographic, socio-economic and environmental conditions still affect the EU rural areas (European Commission, 2006; Hoggart *et al.*, 1995; Copus *et al.*, 2008). Also the lack of comparable statistics, at a disaggregated level, is usually considered as a substantial obstacle preventing a comprehensive definition of rurality (Bertolini *et al.*, 2008; Bertolini and Montanari, 2009). However, some indicators (for instance, demographic density) are universally considered valid criteria to define these regions.

The most widely cited urban-rural typologies are those proposed by the OECD (1994; 1996; 2006) and by the EC (Eurostat, 2010): both follow a similar approach based on the demographic density and the presence of major urban areas. According to the OECD-Eurostat methodologies, NUTS 3 regions in EU-27 Member States are classified as *predominantly urban* (PU), *intermediate* (IR) and *predominantly rural* (PR) regions. Therefore, both demographic density and the OECD-Eurostat methodologies are commonly used to define rural areas across Europe.

However, in the "post-industrial rurality" (Sotte *et al.*, 2012), these dichotomous definitions of rural areas (mostly based on density) are outdated. The same OECD, and recently also the FAO, has opened a new research line in order to establish a qualified set of variables in order to more properly measure the extent of rurality also at the EU level (FAO-OECD Report, 2007; The Wye Group, 2007). Therefore, multidimensional approaches are increasingly suggested in defining rural and urban areas.

Following this idea, a comprehensive PeripheRurality Indicator (PRI) has been computed by Camaioni *et al.* (2013). This synthetic indicator is obtained by applying a principal component analysis (PCA) to a set of 24 variables, grouped in four different thematic areas:

- Socio-demographic characteristics (7 indicators) focusing on the demographic structure and on the major demographic trends;
- Structure of the economy (7 indicators) referring to the structural composition of the regional economy (share of agricultural activities, manufacturing sectors and services on total economy, per capita GDP…);
- Land use characteristics (3 indicators) taking into account the presence of forests, agricultural areas and artificial areas;
- Geographical features (7 indicators) mainly referring to the accessibility of regions and their distance from major urban areas, that is, variables expressing the degree of peripherality or remoteness of the region (this explains the name of the synthetic indicator, *PeripheRurality*) (Camaioni *et al.*, 2013).

Data about these variables have been collected at the NUTS 3 level. The PCA extracted the following Principal Components (PCs):

- PC1 – Economic and geographical centrality;
- PC2 – Demographic shrinking and ageing;
- PC3 – Manufacturing in rural areas with well performing labour market;
- PC4 – Land Use: forests vs. agricultural areas;

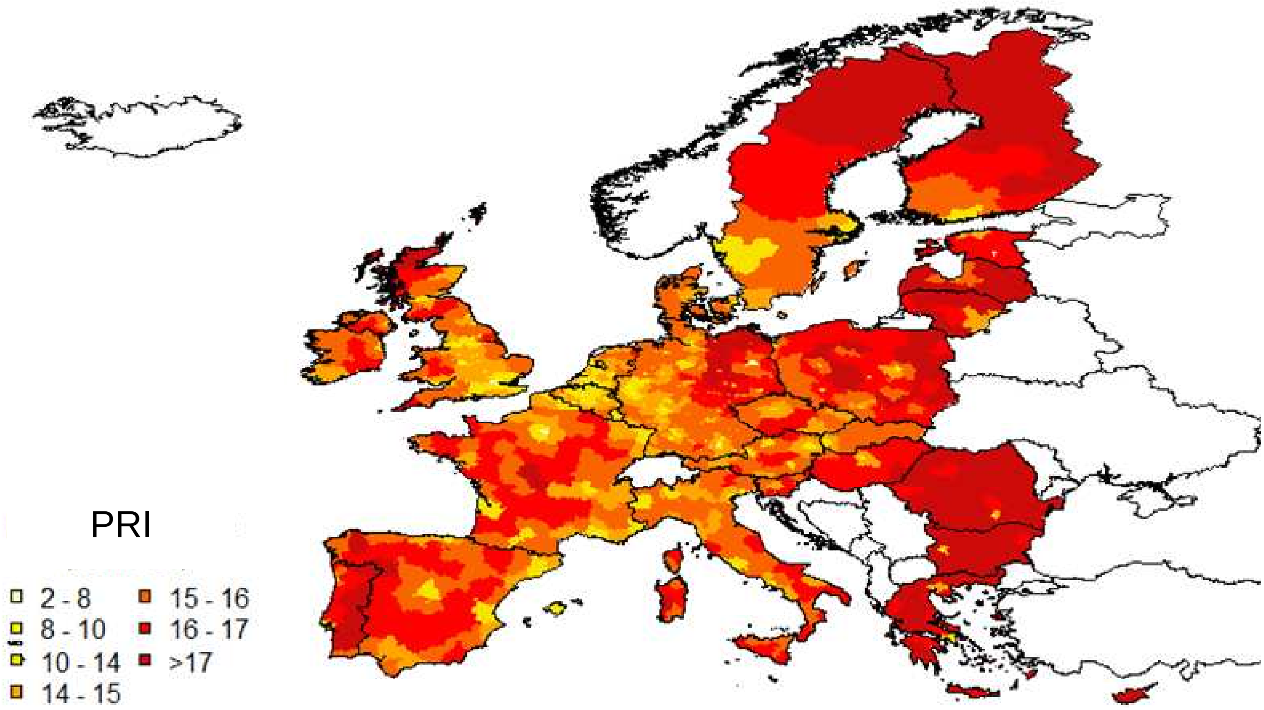
- PC5 – Urban dispersion.

The comprehensive PRI is then computed from these five PCs. Firstly, an ideal region characterized by extreme urban features is established. This European ‘urban benchmark’ is defined calculating, for each PC, the average score between the only two EU global Metropolitan Economic Growth Areas (MEGAs), Paris and London (ESPON, 2005). Secondly, the distance between any NUTS 3 and this urban benchmark is computed for all the PCs. The PRI of the *i*-th region is then computed as the following Euclidean distance (Camaioni *et al.*, 2013):

$$PRI_i = \sqrt{\sum_p \left(x_{ip} - x_{ubp}\right)^2}\ ,\ \forall i \in N \qquad (1)$$

where $N = 1, \ldots, n$ indicates the set of regions under consideration, x_{ip} represents the *i*-th region’s score for the *p*-th PC and x_{ubp} represents the urban benchmark’s score for the *p*-th PC. By construction, the greater the PRI the more rural and/or peripheral the *i*-th region is. The computed values of the PRI are shown in Figure 4.

Figure 4 - PRI across EU NUTS 3 regions



Source: author’s elaboration

In order to take into account these possible measures of rurality, in the present analysis the rural effect will be alternatively expressed by the following indicators:

- Demographic density (the lower the density the more rural the region);
- PRI (the greater the PRI, the more rural the region);
- Eurostat (2010) typologies (*Predominantly Rural, PR,* regions, *Intermediate, IR,* regions and *Predominantly Urban*, *PU,* regions).

3. THE ECONOMETRIC SPECIFICATIONS

3.1. The OLS model

The first suggested model to test the main drivers in the allocation of the RDP support across EU NUTS 3 regions is a simple Ordinary Least Squares (OLS) model. It does not take into account any specific spatial effect. The model can be expressed in the following form:

$$\mathbf{Y} = \mathbf{D}\boldsymbol{\beta} + \gamma\mathbf{X} + \boldsymbol{\varepsilon} \quad (2)$$

where: **Y** is the (n x 1) vector indicating the RDP expenditure intensity (alternatively expressed per UAA, AWU, .000 €). **D** is the (n x 27) matrix of country dummies and **β** is the (27 x 1) vector or respective unknown parameters expressing the *country effect*. Actually, to avoid perfect collinearity, one country dummy must be skipped (Austria is skipped in the present case). However, here **β** also includes the constant term and this explains the dimension of both **D** and **β** (see Table A1).

X is, alternatively, a (n x 1) vector expressing the degree of rurality, that is, density (negatively related to rurality), PRI (positively related to rurality) or a (n x 2) matrix of dummies indicating urban-rural typologies (PR, IR, PU regions); γ is the respective unknown parameter indicating the *rural effect*. **ε** is a (n x 1) vector of i.i.d N~(0,σ^2**I**) disturbance terms. Therefore, (2) implicitly assumes no spatial correlation across units (regions) and, consequently, excludes the presence of a *pure spatial effect*.

3.2. Testing for spatial autocorrelation: the Moran's I statistics

The OLS model method of estimation is not appropriate in case of spatially correlated disturbance terms, that is, whenever $E(\varepsilon_i \varepsilon_j) \neq 0,\ i, j \in N$. This evidently happens when there is spatial correlation in the observed dependent variables **Y** that is not fully taken into account by the independent variables, **D** and **X**. In order to test the presence of this spatial dependence we compute the Moran's I statistics on the both the dependent variables, **Y**, and the estimated residuals of the OLS model, $\hat{\boldsymbol{\varepsilon}}$ (Moran, 1950; Cliff and Ord, 1981). This statistic is a very synthetic measure of spatial autocorrelation, and is defined as follows:

$$I = \frac{n}{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}} \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(y_i - \bar{y})(y_j - \bar{y})}{\sum_{i=1}^{n}(y_i - \bar{y})^2},\ \forall i, j \in N$$

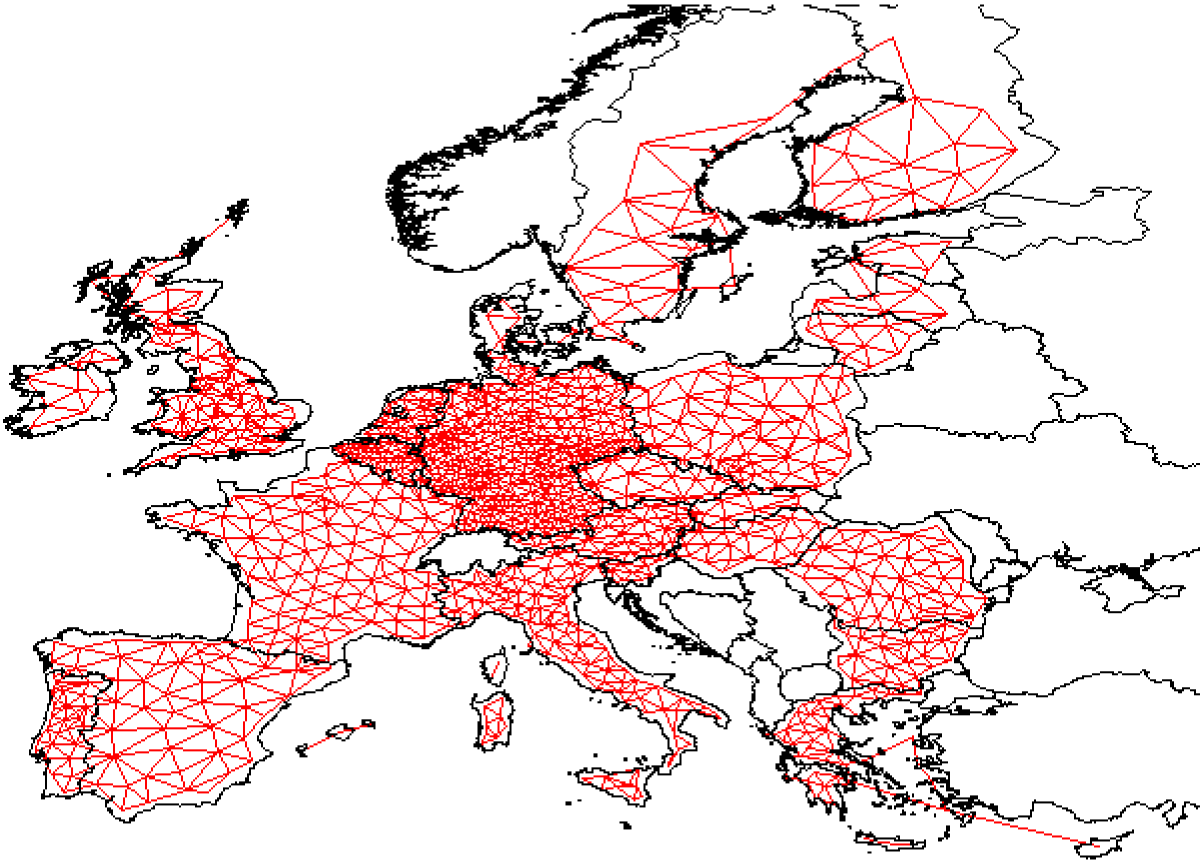
$$I = \frac{n}{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}} \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}\,\hat{\varepsilon}_i\,\hat{\varepsilon}_j}{\sum_{i=1}^{n}\hat{\varepsilon}_i^{\,2}},\ \forall i, j \in N \quad (3)$$

where w_{ij} is the generic element of a row-standardized spatial weights matrix (**W**) defined as follows:

$$w_{ij} = \frac{w_{ij}^*}{\sum_{j=1}^{n} w_{ij}^*} \quad (4)$$

The generic element w_{ij}^* in (4) can take two different values: $w_{ij}^* = 1$ when $i \neq j$ and $j \in N(i)$; $w_{ij}^* = 0$ when $i = j$ or $i \neq j$ and $j \notin N(i)$, where $N(i)$ is the set of neighbours of the i-th region, according to a first-order queen contiguity matrix. Within this approach, two regions are considered as neighbours only if they share a common boundary or vertex (Anselin, 1988). The queen contiguity matrix is preferred to other possible spatial matrix (e.g., those based on the nearest neighbours) because it better suits the case under study (NUTS 3 regions across the EU27) presenting a great heterogeneity in terms of size that inevitably affect the distances[2]. However, when dealing with the contiguity matrices here adopted, a major issue is represented by islands, that clearly do not have any contiguous region. In our sample there are 25 islands. They have been considered contiguous to only one region, the closest in terms of geographical proximity[3]. The geographical representation of this adjusted contiguity matrix is shown in Figure 5 where any link represents a non-zero element of **W**. Table 1 reports the distribution of the number of contiguous (or links) within the sample of NUTS 3 regions. Each observation shows, on average, 5.04 neighbouring regions (i.e. links).

Figure 5 – Geographical representation of the first-order queen contiguity matrix



Source: author's elaboration

Table 1 – Distribution of neighbouring regions (links) within the sample

Number of neighbouring regions	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
Number of observed regions	68	97	142	188	242	233	178	91	29	12	5	3	1288

This row-standardized spatial weights matrix (W) can be used to compute the global Moran's I statistic both on the original variables, to assess the degree of spatial dependency in the distribution under

[2] However, an alternative distance matrix based on the 5 nearest neighbours has been used to check the robustness of results.
[3] In defining this contiguity matrix, no distinction has been made between trans-national neighbours and national neighbours. We are aware that national borders may still represent an "institutional" obstacle when considering the real connectivity among regions. The same is true, however, even for "natural" obstacles between two regions (for instance neighbouring regions sharing a mountains chain as the main border). All these aspects have been disregarded here but could be considered in a more sophisticated construction of **W**.

study (see Table 4), and on the estimated disturbance terms of the various alternative models to assess whether spatial dependence remains after estimation.

3.3. Including the spatial effects

The presence of spatial autocorrelation makes the OLS estimates biased and inconsistent. Therefore, to take it into account, model (2) can be properly modified by making the spatial effects explicit. This allows directly estimating the *pure spatial effect* and getting rid of the spatial correlation. The first step in this direction is a Spatial Durbin Model. This model adds to the original specification the neighbours' average values of the independent variables:

$$\mathbf{Y} = \mathbf{D}\boldsymbol{\beta} + \gamma\mathbf{X} + \theta\mathbf{W}\mathbf{X} + \boldsymbol{\varepsilon} \tag{5}$$

where $\mathbf{Y}$, $\mathbf{D}$, $\boldsymbol{\beta}$, $\mathbf{X}$, γ and $\boldsymbol{\varepsilon}$ have the same meaning of (2); $\mathbf{W}$ is the (n x n) row-standardised spatial weight matrix (first-order queen contiguity matrix) and θ is the unknown parameter expressing the *pure spatial effect*.

Beside the usual possible problems of multicollinearity and heteroskedasticity[4], this model does not pose particular econometric problems as parameters can be consistently estimated with OLS estimation. Also the economic interpretation is relatively straightforward. The *pure spatial effect* here is given by the spatially-lagged rural effect (i.e., the degree of rurality of the neighbouring regions). Therefore, if parameters θ and γ share the same sign, it implies that the intensity of support received by a given region responds in the same direction to an increase (decrease) of its own degree of rurality and of the neighbouring regions. We interpret this case as evidence of rural/rural cooperation (or integration) and of rural/urban competition. On the contrary, different signs of θ and γ imply that the intensity of support responds in opposite directions to an increase (decrease) of its own degree of rurality and of the neighbouring regions. This case can be thus interpreted as an evidence of rural/rural competition and rural/urban cooperation (integration). Beside this economic interpretation, however, the estimation of the Spatial Durbin Model might not eliminate the spatial correlation of the estimated disturbance terms. Therefore, after the estimation of model (5), Moran test is again performed on the estimated disturbances.

In the case of a persistent spatial correlation, two alternative spatial models can be specified and estimated. They both directly address the spatial dependence in the error terms. The first is the Spatial Error Model (SEM). It includes the spatial influence within the error terms as follows:

$$\begin{aligned} \mathbf{Y} &= \mathbf{D}\boldsymbol{\beta} + \gamma\mathbf{X} \\ \boldsymbol{\varepsilon} &= \lambda\mathbf{W}\boldsymbol{\varepsilon} + \mathbf{u} \end{aligned} \tag{6}$$

where λ is the unknown parameter indicating the spatial dependence of the error term $\boldsymbol{\varepsilon}$. Therefore, in this specification λ incorporates the *pure spatial effect.* $\mathbf{u}$ is a (n x 1) vector of i.i.d N~$(0, \sigma^2_u \mathbf{I})$ disturbance terms.

The economic interpretation of this model is that RDP expenditure intensity is affected by the over- (or under-)support received by the neighbouring regions (regardless of their degree of rurality). According to the observed sign of the spatial effects, the model can be interpreted in terms of place (territorial)-based effects. If parameter λ shows a positive sign, a sort of "local agglomeration" effect of the over-(under-)support is observed in the allocation of the RDP expenditure. On the contrary, a negative sign indicates that a cross-compensation of over- and under-support is observed among neighbouring regions. Since the units under consideration are NUTS 3 regions, here this cross-compensation could be viewed as a "intra NUTS 2

[4] Heteroskedasticity often occurs in these models, dealing with similar data.

compensation” effect. Given the *ex-ante* allocation of support to a given NUTS 2 region (decided at the EU or country level), an over-support going to some NUTS 3 region, and independent from its degree of rurality, must be necessarily compensated by an under-support for some neighbouring regions. Specification (6) can not be consistently estimated with OLS estimation both for the presence of non-spherical disturbances and because the model is no longer linear in the parameters because of the new unknown parameter λ. Consistent estimates of $\boldsymbol{\beta}$, γ and λ are thus obtained by Maximum Likelihood Estimation (MLE) (Anselin, 1988; Anselin and Bera, 1998).

A further model specification making the spatial effect explicit is the Spatial AutoRegressive (SAR) model. It assumes that different levels of the dependent variable *Y* (i.e., the intensity of the RDP support) also depend on the levels of *Y* in neighbouring regions, according to the following specification:

$$\mathbf{Y} = \mathbf{D}\boldsymbol{\beta} + \gamma\mathbf{X} + \rho\mathbf{W}\mathbf{Y} + \boldsymbol{\varepsilon} \tag{7}$$

where ρ is the unknown parameter expressing the pure *spatial effect*. It indicates to what extent the support received by neighbouring units affects the expenditure intensity of a given region. $\boldsymbol{\varepsilon}$ is a (*n* x 1) vector of i.i.d N~(0,σ^2**I**) disturbance terms.

This model can be interpreted as a combination of the previous two models. With a straightforward transformation, we can express (7) as:

$$\mathbf{Y} = (\mathbf{I} - \rho\mathbf{W})^{-1}\mathbf{D}\boldsymbol{\beta} + \gamma(\mathbf{I} - \rho\mathbf{W})^{-1}\mathbf{X} + (\mathbf{I} - \rho\mathbf{W})^{-1}\boldsymbol{\varepsilon} \tag{8}$$

(8) shows that in (7) the spatial dependence actually implies non-spherical disturbances and that linearity in parameters does not hold true for ρ. Therefore, as for (6), consistent estimation of (7) is performed through MLE. The spatial effect ρ here expresses both the effect of the degree of the neighboring regions as well as their over (under) support.

4. RESULTS

Before presenting the estimates of models (2), (5), (6) and (7), some descriptive statistics can provide some evidence on the distribution of RDP expenditure across EU NUTS 3 regions. In particular, of major interest is the relationship between the three indicators of expenditure intensity and the three indicators of rurality. Table 2 reports the Pearson correlation coefficients between these two groups of indicators. When density is considered, the RDP expenditure intensities are not significantly correlated to rurality, with the only exception of expenditure per AWU that is positively correlated with density (i.e., the more densely-populated the region, the more the expenditure intensity). Significant correlation, on the contrary, is found when rurality is expressed with the PRI. Even in this case, however, more central and urban regions (i.e., those characterised by a lower PRI value) show a greater intensity of RDP expenditure, again with the only exception of expenditure per unit of agricultural GVA.

Similar findings emerge when looking at the distribution of RDP expenditure according to the Eurostat definition of rural regions, that is, the urban-rural typologies (*PU*, *IR* and *PR* regions). Table 3 confirms that urban areas generally show greater intensity of RDP support than more rural regions, thus confirming the existence of a negative rural effect. Nonetheless, this quite robust descriptive evidence should be taken wit caution. In fact, the correlation observed between RDP expenditure intensity and the extent of rurality may actually hide other effects across space that can be confused with the effect of rurality. In order to investigate the relevance of these effects across space, global Moran’s I test is performed on expenditure intensity indicators. Table 4 shows these test results for two different spatial weight matrices: the first is the above-mentioned first-order queen contiguity matrix; the second is a 5 nearest neighbours matrix (for each observation, the average values of the five nearest regions is considered). Results from both cases suggest the existence of a significant spatial autocorrelation across EU observations. The question thus becomes whether the country and the rural effects capture all the spatial dependence in RDP expenditure or there is something else.

To answer this question, the analysis must move from this descriptive evidence to models estimation. Moving from these preliminary results, the OLS model is estimated. Tables 5 to 8 report the estimates of model (2), (5), (6) and (7), respectively. Due to space limitations, these tables do not report the estimates of $\boldsymbol{\beta}$, that is, of the constant term and of the country effects. For specifications referring to the RDP expenditure per UAA, these estimated parameters are reported for all models in the Table A.1 (Annex). They suggest that the *country effects* are mostly statistically significant, that is, the country always matters in the allocation of the RDP funds, and that expenditure intensity tends to be larger in some new member states (Czech Republic, Slovenia and Slovakia, for instance), in Scandinavian countries and in western peripheral countries (Ireland and Portugal).

Table 2 – Pearson correlation coefficients among indicators of RDP expenditure intensity (2007-2009) and of rurality

	Density	**PRI**
RDP expenditure per UAA	0.033	-0.023*
	(0.245)	(0.416)
RDP expenditure per AWU	0.091**	-0.073**
	(0.001)	(0.009)
RDP expenditure per agric. GVA	-0.009	0.090**
	(0.760)	(0.001)

**, *: statistically significant at the 1%, 5%, respectively

Table 3 – Average RDP expenditure intensity (2007-2009) per Eurostat urban-rural typologies

	RDP expenditure (€) per UAA (ha)	**RDP expenditure (€) per AWU**	**RDP expenditure (€) per agric. GVA (.000 €)**
Predominantly Rural (PR) regions	130.76	3,048.21	154.72
Intermediate (IR) regions	111.33	2,997.10	117.72
Predominantly Urban (PU) regions	101.07	2,625.86	89.82

Table 4 – Global Moran's I statistics for the intensity of the RDP expenditure (2007-2009)

	First-order queen contiguity matrix		**5 nearest neighbours matrix**	
	Moran's I	**p-value**	**Moran's I**	**p-value**
RDP expenditure per UAA	0.4378	0.000	0.4229	0.000
RDP expenditure per AWU	0.3682	0.000	0.3693	0.000
RDP expenditure per agric. GVA	0.3513	0.000	0.3457	0.000

Therefore, the tables only report the estimates of parameters γ (the *rural effect*) and of parameters θ, λ, and ρ, respectively (the *pure spatial effect*), together with tests of spatial correlation on estimated residuals (Moran or LM tests). Estimates are separately reported for the three indicators of expenditure intensity and for the alternative measures of rurality. Limiting the discussion to statistically significant parameter estimates, we can firstly notice that in the case of OLS estimation (Table 5), the PRI negatively influences the RDP expenditure per UAA, whereas it is positively affects the RDP expenditure per agricultural GVA. Measuring rurality with density confirms this evidence as it positively affects the RDP expenditure per UAA. On the contrary, the dummies associated to the Eurostat urban-rural typologies does not provide significant parameter estimates, thus confirming that such indicator of rurality may be too rough to really capture the allocation patterns across the EU space. According to these OLS estimates, however, it is confirmed that the RDP expenditure per UAA tends to be greater in more central and more urban areas, whereas it is generally lower in more rural and peripheral ones. However, the Moran tests on OLS residuals also suggest the presence of spatial autocorrelation. Not only this makes the OLS estimates biased and inconsistent. It also suggests that there are other factors, beside the country and the degree of rurality, that affects RDP fund allocation across space.

A first attempt to get rid of the spatial correlation of the error term is the Spatial Durbin Model whose estimates are provided in Table 6. As obvious, this model does not apply to the specification where rurality is expressed by the Eurostat typology dummies, since they can not be spatially lagged. According to the estimation results, the extent of peripherurality (density) negatively (positively) affects the RDP expenditure intensity; on the contrary, the extent of peripherurality (density) in neighbouring regions positively (negatively) affects it. The former result confirms previous findings (Shucksmith *et al.*, 2005): whenever the country effect is properly taken into account, the degree of rurality still matters but it eventually operates in the opposite direction: urban and more densely populated regions show a greater RDP expenditure intensity than more rural ones. For both rurality indicators, the spatially lagged variable shows the opposite signs, and this seems consistent with the presence of a rural/rural competition and rural/urban integration at the NUTS 3 level. However, this model does not fully remove the spatial autocorrelation across residuals, as indicated by the Moran test. OLS estimation of $\boldsymbol{\beta}$, γ and θ thus remains biased and inconsistent.

Since they directly take into account spatial dependence within respective specifications, the SEM and the SAR model are expected to restore spherical disturbances, thus providing consistent parameter estimates. Table 7 reports the estimates of the SEM. Results confirm what obtained from previous model specifications: γ is negative for PRI, positive for density and not significant for PR and PU dummies. Therefore, the rural effect has a negative impact on the intensity of RDP support. Moreover, parameter λ indicating spatial correlation is positive and highly significant in all the specifications. According to this result, the existence of a "local agglomeration" effect in the allocation of the RDP support seems to prevail on the "intra NUTS 2 compensation" effect that would be suggested by a negative sign of λ.

As mentioned, the SAR model should get rid of the spatial dependence with a sort of combination of the previous two spatial models. Table 8 shows that also in the SAR model a negative rural effect is observed. However, parameter ρ is significant and positive, thus suggesting that a pure spatial effect occurs and that, in the allocation of RDP support across EU NUTS 3 regions, neighbourhood matters. The positive sign can be interpreted as a combination of a "local agglomeration" effect and a "rural/rural competition" or "urban/rural integration" effect. Testing for spatial autocorrelation of the SAR estimated residuals, no further spatial dependence is found, thus suggesting that this specification is capable of capturing all the spatial effects in action.

Table 5 – Model (2) OLS estimates (standard errors in parenthesis)[a]

	RDP expenditure per UAA	RDP expenditure per AWU	RDP expenditure per agric. GVA
γ_{PRI}	-3.995**	66.71	4.612*
	(1.522)	(55.85)	(2.315)
Moran test on residuals	0.208***	0.216***	0.204***
$\gamma_{Density}$	0.016***	0.353**	0.005
	(0.004)	(0.127)	(0.005)
Moran test on residuals	0.215***	0.242***	0.222***
$\gamma_{Eurostat\ PR}$	1.147	141.2	14.60
	(5.891)	(223.0)	(9.65)
$\gamma_{Eurostat\ PU}$	-3.435	-432.1	-25.24*
	(6.782)	(255.7)	(10.98)
Moran test on residuals	0.190***	0.216***	0.203***

***, **, *: statistically significant at the 0.1%, 1%, 5%, respectively

[a] Constant and country dummies' parameters are not reported; see Table A1.

Table 6 – Spatial Durbin Model MLE estimates (standard errors in parenthesis)[a]

	RDP expenditure per UAA	RDP expenditure per AWU	RDP expenditure per agric. GVA
γ_{PRI}	-12.74***	-281.08***	-7.553**
	(1.829)	(67.32)	(2.851)
$\theta_{PRI\ spatially\ lagged}$	22.41***	911.82***	31.387***
	(2.744)	(104.53)	(4.443)
Moran test on residuals	0.198***	0.175***	0.184***
$\gamma_{Density}$	0.031***	0.930***	0.028***
	(0.004)	(0.146)	(0.006)
$\theta_{Density\ spatially\ lagged}$	-0.039***	-1.628***	-0.063***
	(0.006)	(0.217)	(0.009)
Moran test on residuals	0.210***	0.225***	0.212***

***, **, *: statistically significant at the 0.1%, 1%, 5%, respectively

[a] Constant and country dummies' parameters are not reported; see Table A1.

Table 7 – SEM MLE estimates (asymptotic standard errors in parenthesis)[a]

	RDP expenditure per UAA	RDP expenditure per AWU	RDP expenditure per agric. GVA
γ_{PRI}	-10.362***	-205.49***	-5.213*
	(1.610)	(58.86)	(2.470)
λ	0.464***	0.480***	0.483***
	(0.032)	(0.031)	(0.031)
$\gamma_{Density}$	0.027***	0.817***	0.024***
	(0.000)	(0.130)	(0.000)
λ	0.462***	0.493***	0.503***
	(0.032)	(0.031)	(0.030)
$\gamma_{Eurostat\ PR}$	-1.879	64.08	5.45
	(5.690)	(212.01)	(9.20)
$\gamma_{Eurostat\ PU}$	5.581	58.23	-11.30
	(7.110)	(267.03)	(11.50)
λ	0.404***	0.445***	0.455***
	(0.033)	(0.032)	(0.031)

***, **, *: statistically significant at the 0.1%, 1%, 5%, respectively

[a] Constant and country dummies' parameters are not reported; see Table A1.

Table 8 – SAR model MLE estimates (asymptotic standard errors in parenthesis)[a]

	RDP expenditure per UAA	RDP expenditure per AWU	RDP expenditure per agric. GVA
γ_{PRI}	-5.977***	-78.48	-0.775
	(1.410)	(51.17)	(2.130)
ρ	0.415***	0.447***	0.440***
	(0.032)	(0.032)	(0.032)
LM test on residuals' autocorrelation	0.292	6.905***	2.228
$\gamma_{Density}$	0.019***	0.568***	0.013**
	(0.000)	(0.120)	(0.000)
ρ	0.417***	0.461***	0.454***
	(0.032)	(0.031)	(0.031)
LM test on residuals' autocorrelation	0.799	2.155	5.723**
$\gamma_{Eurostat\ PR}$	-1.17	18.47	5.57
	(5.470)	(204.92)	(8.910)
$\gamma_{Eurostat\ PU}$	1.78	-53.84	-11.73
	(6.300)	(234.95)	(10.14)
ρ	0.397***	0.434***	0.428***
	(0.032)	(0.032)	(0.032)
LM test on residuals' autocorrelation	2.150	10.391***	2.010

***, **, *: statistically significant at the 0.1%, 1%, 5%, respectively

[a] Constant and country dummies' parameters are not reported; see Table A1.

5. SOME CONCLUDING REMARKS

This study investigates the main drivers of the RDP expenditure allocation across the EU space by focusing on the most disaggregated territorial level (NUTS 3 level) admitted by data availability. At such a territorial disaggregation, the distribution of the actual expenditure not only depends on the top-down political decisions, but also on the "local" capacity to attract and use these funds. The proposed approach explains funds' allocation as a combination of country, rural and pure spatial effects. The latter expresses the influence of neighbouring regions on RDP expenditure allocation and can be interpreted, in turn, in terms of rural/rural competition or integration effects, and in terms of local agglomeration or compensation effects.

The different model specifications are quite concordant in suggesting some univocal and robust empirical evidence about the distribution of the RDP expenditure intensity. First of all, country matters as regions belonging to some countries tend to receive more (less) than other countries. This result is neither new nor surprising but it still suggests that disregarding the country effect may erroneously identify in other factors, for instance the degree of rurality, the main drivers of fund allocation. The most relevant result is, in fact, the role of rurality. As could be expected, rurality matters in the allocation of RDP expenditure but it operates in the opposite direction: the less the region is rural, the higher the expenditure intensity.

The major objective of the present study, however, is to investigate whether and how neighbourhood matters in the allocation of funds and provide some tentative interpretations for this. Estimates agree in showing that neighbouring regions play a role and are also concordant in indicating the direction of this influence. More rural neighbouring regions reduce the RDP expenditure intensity thus suggesting a sort of rural/rural competition, while over- (under-) support in neighbouring regions tends to induce over- (under-) support also within the region under question ("local agglomeration" effect).

Both the magnitude and direction of this spatial or local conditioning of RDP fund allocation represent the main results of the present study. At the same time, however, they also represent the main challenge for future research emerging from this approach. More sophisticated spatial econometric specifications and estimations could be put forward to explicitly investigate and test the abovementioned interpretations of the observed spatial dependence. In addition, a more in-depth empirical investigation could be attempted by disaggregating the RDP expenditure into axes and measures thus linking disaggregated expenditure intensity to specific socio-economic characteristics of the regions. More generally and importantly, a theoretical explanation of the concentration of RDP expenditure intensity in a given region and of the influence of the neighbourhood is still missing. Political economy models could provide useful insight into the mechanisms underlying the observed spatial distribution and dependence.

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ANNEX

Table A.1 reports the estimates of parameters in **β** (constant term and country effects) for models (2), (5), (6) and (7) when the RDP expenditure per UAA is used as dependent variable (**Y**) and rurality (**X**) is measured by the PRI.

Table A.1 – Constant term and country effect estimates (standard errors/asymptotic standard errors in parenthesis)

	OLS Model	**Spatial Durbin Model**	**SEM**	**SAR model**
Constant	382.78***	173.99***	460.40***	292.08***
	(27.53)	(37.06)	(31.39)	(27.66)
Belgium	-231.16***	-213.90***	-207.63***	-148.81***
	(19.99)	(19.60)	(27.84)	(19.46)
Bulgaria	-230.79***	-273.32***	-192.40***	-133.16***
	(22.68)	(22.71)	(31.95)	(21.89)
Cyprus	-124.37	-125.03	-50.58	-28.96
	(88.29)	(86.05)	81.98	(81.62)
Czech Republic	-132.39***	-139.80***	-130.18***	-80.89**
	(27.57)	(26.89)	(34.44)	(25.69)
Germany	-203.80***	-202.18***	-184.56***	-132.43***
	(15.49)	(15.10)	(20.66)	(15.29)
Denmark	-270.60***	-249.16***	-245.89***	-175.44***
	(31.24)	(30.57)	(45.21)	(29.74)
Estonia	-179.12***	-199.63***	-145.70*	-107.30**
	(41.62)	(40.64)	(62.62)	(38.72)
Spain	-267.33***	-272.16***	-248.80***	-171.29***
	(19.30)	(18.82)	(27.80)	(19.26)
Finland	-47.59	-60.17*	-27.05	-35.70
	(24.52)	(23.95)	(37.89)	(22.64)
France	-235.89***	-235.46***	-212.19***	-149.65***
	(17.35)	(16.91)	(24.34)	(17.26)
Greece	-181.32***	-207.06***	-152.60***	-113.56***
	(19.44)	(19.20)	(28.34)	(18.61)
Hungary	-180.73***	-192.66***	-142.23***	-114.78***
	(24.93)	(24.34)	(33.85)	(23.41)
Ireland	-86.35*	-91.13**	-56.37	-56.19
	(36.04)	(35.13)	(80.55)	(33.33)
Italy	-230.88***	-230.78***	-204.76***	-148.28***
	(17.09)	(16.66)	(23.67)	(16.94)
Lithuania	-181.20***	-217.36***	-168.71***	-114.20***
	(31.40)	(30.79)	(44.69)	(29.48)
Luxembourg	-78.36	-87.74	-53.27	4.16
	(88.15)	(85.92)	(80.55)	(81.58)
Latvia	-229.49***	-250.64***	-197.43***	-146.92***
	(41.67)	(40.69)	(54.06)	(38.90)
Malta	-7.50	7.17	5.33	-20.79
	(63.19)	(61.61)	(106.55)	(58.34)
Netherlands	-276.25***	-256.21***	-256.99***	-180.28***
	(20.32)	(19.96)	(28.55)	(20.19)
Poland	-204.37***	-221.43***	-188.74***	-132.84***
	(18.40)	(18.06)	(26.06)	(17.90)
Portugal	-107.85***	-124.26***	-90.58**	-65.98**
	(22.23)	(21.76)	(32.22)	(20.73)
Romania	275.23***	-316.38***	-235.83***	-164.55***
	(20.72)	(20.81)	(29.62)	(20.62)
Sweden	-180.05***	-183.63***	-154.95***	-116.18***
	(24.10)	(23.50)	(36.67)	(22.73)
Slovenia	70.20*	68.83*	62.03	43.54
	(29.17)	(28.43)	(37.10)	(27.03)
Slovakia	-102.11***	-108.85**	-87.93*	-65.00*
	(34.12)	(33.26)	(39.80)	(31.62)
United Kingdom	-249.57***	-238.04***	-234.01***	-159.15***
	(16.92)	(16.55)	(23.97)	(17.01)

***, **, *: statistically significant at the 0.1%, 1%, 5%, respectively