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 what influences the distribution of the RDP funds across the EU space. Eventually, funds 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 1300 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 given region is the larger is the amount of RDP support it is expected to receive. In practice, 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 amount of support received by a region of the bordering regions and, in particular, of their degree of rurality. These effects are estimated adopting and estimating alternative spatial model specifications: the spatial Durbin model, the SEM and the SAR model.

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

JEL Classification codes: R58, Q01, O18

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Esposti R.[1], Pagliacci F.[1], Camaioni B.[2], Sotte F.[1], Lobianco A.[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. Although political decisions determine funds allocation across Countries and at the NUTS2 level, at a lower territorial level, the allocation of funds depends on different local characteristics. Actually, regions and local areas may differ according to their capacity in attracting these funds. Thus, the present paper is aimed at investigating this more "local" allocation, by analysing funds distribution across 1,300 EU NUTS3 regions.

Actually, different effects are admitted as major drivers of this spatial allocation. First, a country effect can be observed: each EU Member State shows different levels of expenditures within the rural development programme, thus confirming the well-known differentials in the intensity of the rural support across EU countries. Then, a specific rural effect should 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. Moreover, a pure spatial effect can also be analysed. Such an effect stresses the idea that the amount of support that is received by a given region is also influenced by both the amount of support received by neighbouring regions and their degree of rurality.

According to this very generic framework, the current paper is aimed at analysing the spatial allocation of these funds, by testing the above-mentioned effects, throughout the implementation of some econometric models: following a very generic OLS model, the spatial Durbin model, the SEM and the SAR model are tested.

The work is organised as follows. Section 2 provides some detailed information about data on RDP expenditures. Moreover, some possible measures of rurality are suggested, in order to assess the rural effect. Section 3 describes the econometric models: i) the generic OLS model that does not take into account any spatial effects; ii) the spatial Durbin model, that accounts for the spatially-lagged independent variable; iii) the SEM model (spatial simultaneous autoregressive error model); iii) the SAR model (spatial simultaneous autoregressive lag model). Section 4 provides the main results from the analysis. Section 5 concludes the paper, by suggesting some remarks for further researches.

2. DATA

2.1. RDP expenditure

The second pillar of the Common Agricultural Policy (CAP) supports the implementation of the rural development policy (RDP) across the EU. This policy is financed by European Agricultural Fund for Rural Development (EAFRD). Such a policy is aimed at supporting rural areas, which still represent a vital part of the EU. In spite of some major weaknesses, those regions have been facing new challenges since the rise of the 'post-industrial rurality' framework (Sotte, 2009; Esposti, 2011; Sotte *et al.*, 2012). In the current 2007-2013 programming period, RDP is aimed 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 economy).

According to this generic framework, EAFRD funds and expenditures do not show a homogenous spatial allocation. In particular, data on total EAFRD expenditures have been collected at the NUTS 3 level, for the whole set of regions across the EU-27 (about 1,300 observations, according to the NUTS 2006 classification). Collected data mainly refer to the total expenditures of RDP, from year 2007 to 2009 (Source: European Commission).

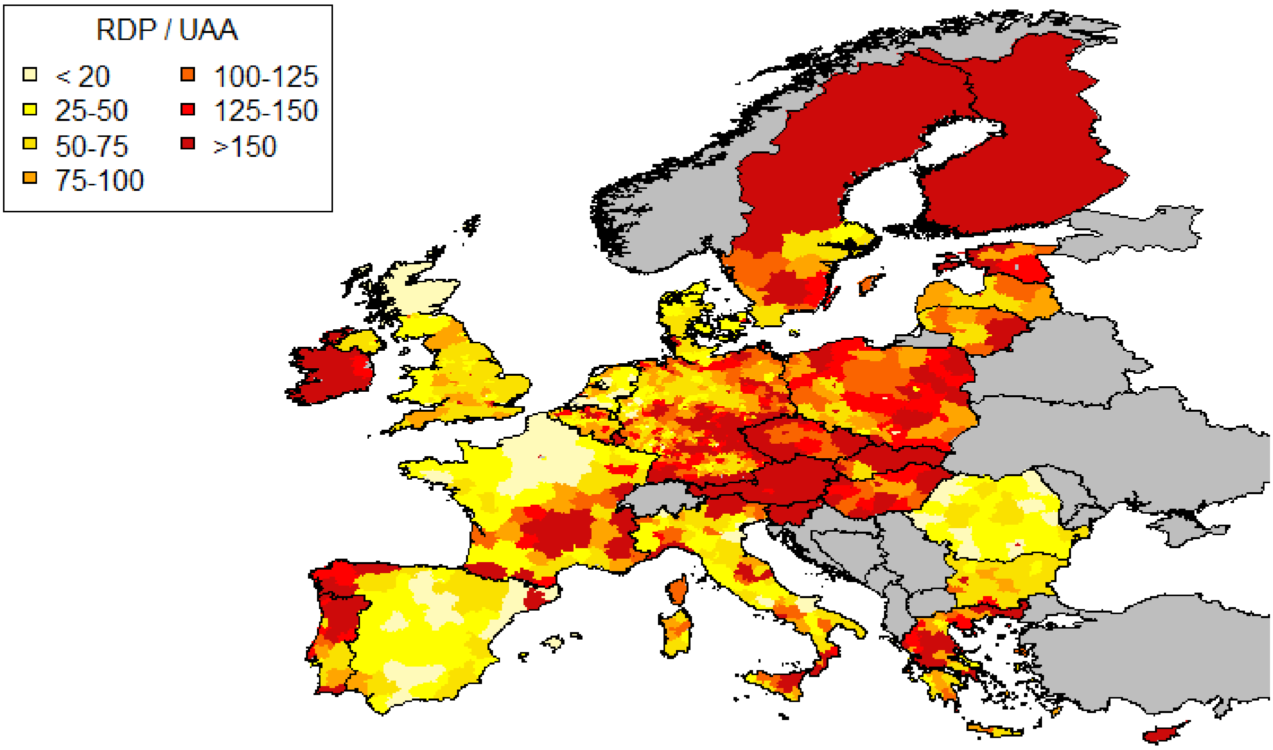
However, in this work, we are not mainly interested in the spatial allocation of the total expenditures: more properly, the analysis is intended to focus on some specific indexes of the intensity of the EAFRD expenditures. Actually, the following intensity indexes have been computed:

1. RDP expenditures per unit of utilized agricultural area (UAA in ha.);
2. RDP expenditures per unit of agricultural labour work (expressed in annual work unit, AWU);
3. RDP expenditures per unit of agricultural gross value added (GVA in million of euros).

Data on utilized agricultural areas and annual work unit are from Eurostat - Farm Structure Survey (2007). Data on agricultural GVA are from Eurostat – National Accounts (average values 2007-2010).

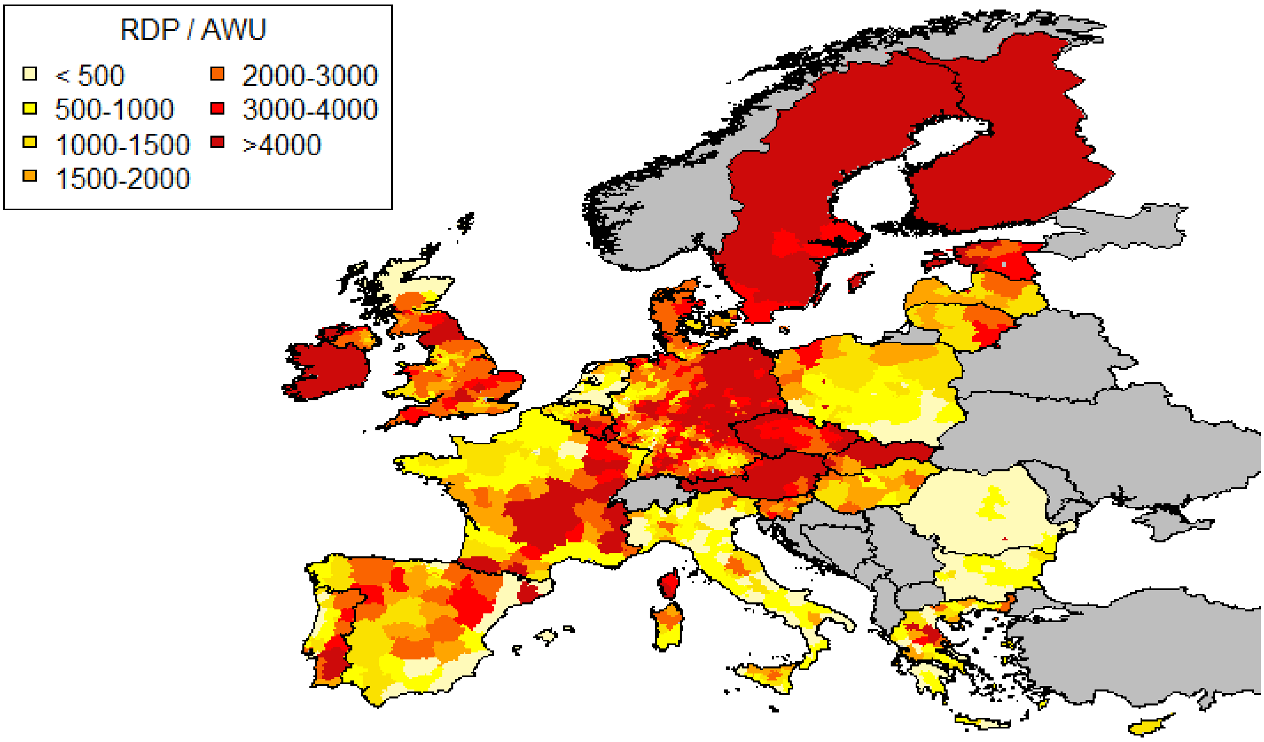
According to a territorial perspective, the distribution of the RDP expenditures is not homogeneous across Europe: actually, these values show great heterogeneity across and within the EU Member States. In particular, in Figure 1, Figure 2 and Figure 3 the territorial distribution of the above-mentioned intensity indexes is shown. Spatial allocation of expenditures' intensity mainly follows major differences across regions: those differences mainly refer to both 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). For example, the intensity or RDP expenditures per unit of UAA is particularly low both in regions in Northern France and in Spain: this is largely due to a greater presence of agricultural areas in those regions. On the opposite side, when considering RDP expenditures per agricultural GVA, this ratio is higher in Eastern Europe Countries regions than in Western Europe ones: this is mainly due to lower values of GVA in the former area.

Figure 1. RDP expenditures per unit of utilized agricultural area (UAA)



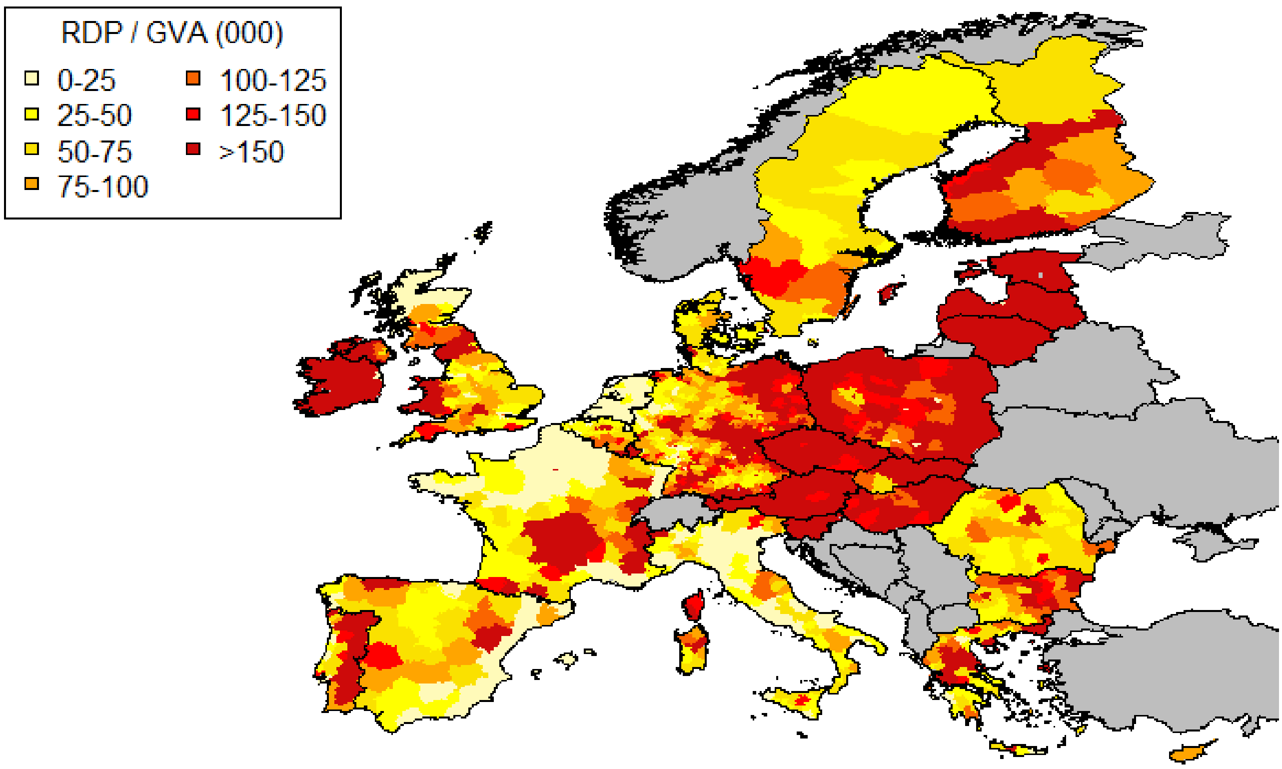
Source: own elaboration on European Commission data (software R, EuroGeographics for administrative boundaries)

Figure 2. RDP expenditures per unit of agricultural labour work (in annual work unit, AWU)



Source: own elaboration on European Commission data (software R, EuroGeographics for administrative boundaries)

Figure 3. RDP expenditures per agricultural GVA



Source: own elaboration on European Commission data (software R, EuroGeographics for administrative boundaries)

Moving from the analysis of the RDP expenditure intensity at the NUTS 3 level, some outliers can be easily detected: they mainly refer to urban areas (e.g., Paris and London), where both the utilized agricultural areas and the agricultural labour work show very low figures (so implying higher levels of the expenditures' intensity). Thus, before moving to the spatial analysis, these outliers have been dropped out from the dataset. In particular, the following observations have not been considered:

- RDP expenditures per unit of utilized agricultural area: 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 unit of agricultural labour work: 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 unit of agricultural gross value added (GVA in million of euros; Wismar Kreisfreie Stadt (DE806); Potsdam Kreisfreie Stadt (DE423); Bruxelles (BE100); Paris (FR101).

2.2. Alternative measures to define rurality

Lately, a wide debate has focused on the definition of rural areas. In spite of it, an official and homogeneous definition, which helps in distinguishing them from urban regions, is hard to find at the international level (Montresor, 2002; Anania and Tenuta, 2008). For example, the EC does not define any formal criterion to identify those areas where rural development policies can be implemented: each Member State is autonomously in charge of defining its own rural areas. Actually, wide differences in terms of demographic, socio-economic, environmental conditions affect the EU rural areas (European Commission, 2006; Hoggart *et al.*, 1995; Copus *et al.*, 2008). Moreover, also the lack of comparable statistics, at a disaggregated level, is usually underlined as a key obstacle in providing comprehensive definitions about rural areas (Bertolini *et al.*, 2008; Bertolini and Montanari, 2009).

However, rural areas have been traditionally defined according to some specific criteria. The most widely cited urban-rural typologies are those from OECD (1994; 1996; 2006) and the EC and Eurostat (Eurostat, 2010): both follow an approach, simply based on demographic density and on the presence of major urban areas. Actually, density has been widely used in order to provide comparable definition about rural 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" framework (Sotte *et al.*, 2012), these dichotomous definitions of rural areas (just based on density) are largely outdated. Within the same OECD, and recently FAO, a new research line was opened, in order to identify new measures of rurality which are based on a qualified set of variables (FAO-OECD Report, 2007; The Wye Group, 2007). Therefore, more multidimensional approaches can be suggested in defining rurality.

According to this idea, a comprehensive Peripherurality Index (PR Index) has been computed in a previous work (Camaioni *et al.*, 2013). This indicator is obtained by applying a principal component analysis (PCA) to a set of 24 different variables, referring to four different thematic areas: socio-demographic features (7 indicators) focus on the demographic structure as well as major demographic trends; structure of the economy (7 indicators) refers to a sector-based analysis (share of agricultural activities, manufacturing sectors and services on total economy, per capita GDP…). These variables have been collected at the level 3 in the NUTS (*Nomenclature of territorial units for statistics*) classification. Then, 5 different PCs are extracted:

- 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).

Moving from the 5 PCs, the comprehensive "*Peripherurality Index*" (PR Index) is then computed. First, an ideal region, which is characterized by very urban features, is set. This European 'urban benchmark' (i.e., a benchmark for urban features across Europe)t is defined moving from the EU global MEGAs: Paris and London (ESPON 1.1.1, 2005). Then, according to each PC, the distance between each NUTS 3 region and this ideal urban benchmark is computed. The Euclidean distance for a generic *n*-dimensional space is assessed. Actually, the distance is computed according to the selected PCs, as they represent specific features of both rurality and remoteness in both a socio-economic and a geographical way. Therefore, the Peripherurality Index can be computed as follows (Esposti *et al.*, 2012):

$$\text{PR Index} = \sqrt{\sum (x_{i1} - x_{ub1})^2 + (x_{i2} - x_{ub2})^2 + \ldots + (x_{ip} - x_{ubp})^2} \quad (1)$$

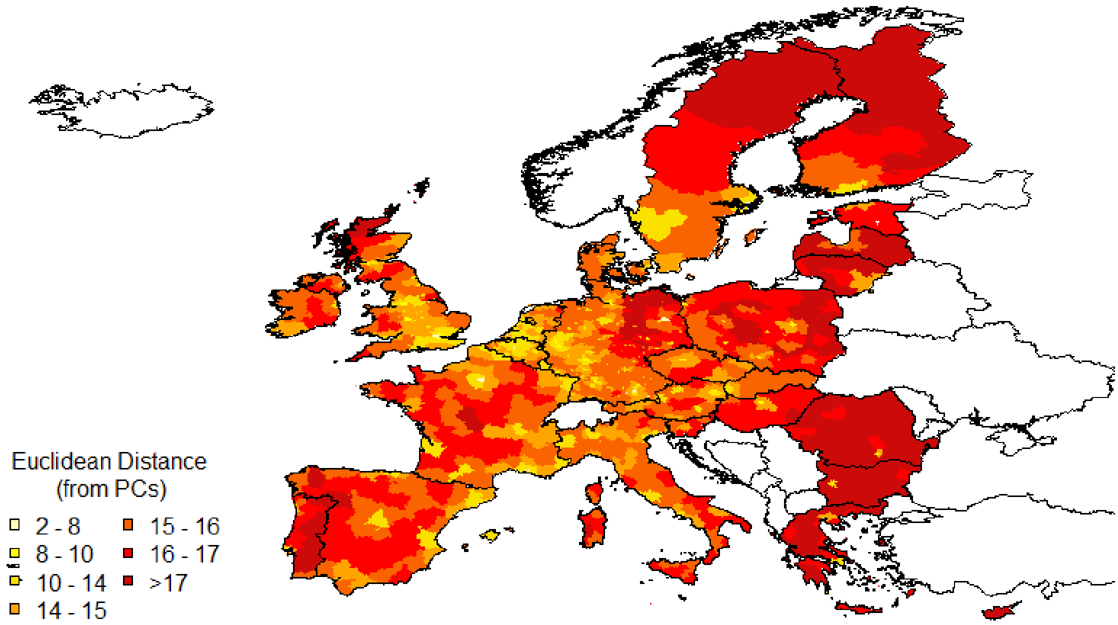
where:

X_{ip} represents the score of the *i*-th NUTS 3 region in the *p*-th component;

X_{ubp} represents the score of the urban benchmark in the *p*-th component.

By construction, the greater the PR Index is, the more rural and/or peripheral a given region is. In Figure 4, the values for the PR Index are shown (according to the NUTS 3 level).

Figure 4. PR Index across NUTS 3 regions in Europe



Source: own elaboration (R Software, EuroGeographics for administrative boundaries)

By construction, the greater the PR Index is, the more rural and/or peripheral a given region is. In Figure 4, the values for the PR Index are shown (according to the NUTS 3 level). According to these different perspectives, in the current work we will adopt alternative measurements of rural areas:

- Demographic density: the lower it is, the more rural a region is;
- PR Index: the greater it is, the more rural a region is;
- Eurostat (2010) typologies: predominantly rural regions, intermediate regions, predominantly urban regions.

3. THE ECONOMETRIC SPECIFICATIONS

3.1. The generic OLS model

The first model is a simple OLS model that does not consider any spatial effects. The model can be expressed in the following form:

$$Y = D\beta + X\gamma + \varepsilon \quad (2)$$

Where:

- Y is the intensity of RDP expenditures (expressed in terms of agricultural utilized area, agricultural labour force and agricultural gross value added);
- D refers to a list of 26 Country dummies (thus highlighting the *country effect*);
- X refers to the rural effect, expressed according to the three above-mentioned measurements: i) demographic density (the lower the density the greater the extent of the rurality); ii) the PR Index (the greater the index, the greater the extent of the rurality); the Eurostat urban-rural typologies (throughout dummies for Predominantly Rural regions, Intermediate Regions, Predominantly Urban regions).

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

Since the traditional Ordinary Least Squares (OLS) method of estimation could be not appropriate in case of spatially correlated observations, it is crucial to identify the presence of spatial dependence in order to take it into account. Thus, after having estimated the OLS model, we will test for spatial autocorrelation of the estimated error terms.

This analysis can be performed by adopting the Moran's I statistics (Moran, 1950; Cliff and Ord, 1981): this is a very synthetic measure of spatial autocorrelation, according to the following definition:

$$I = \frac{n}{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}} \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(y_i-\bar{y})(y_j-\bar{y})}{\sum_{i=1}^{n}(y_i-\bar{y})^2} \qquad (3)$$

where:

- y is the variable under analysis;
- $\bar{y}$ is the mean of y in the sample;
- n is the size of the sample;
- w_{ij} is a generic element of a row-standardized spatial weights matrix W, which can be defined as follows:

$$w_{ij} = \frac{w_{ij}^*}{\sum_j w_{ij}^*} \qquad (4)$$

Moreover, the generic element w_{ij}^* in (2) can take different values, and in particular:

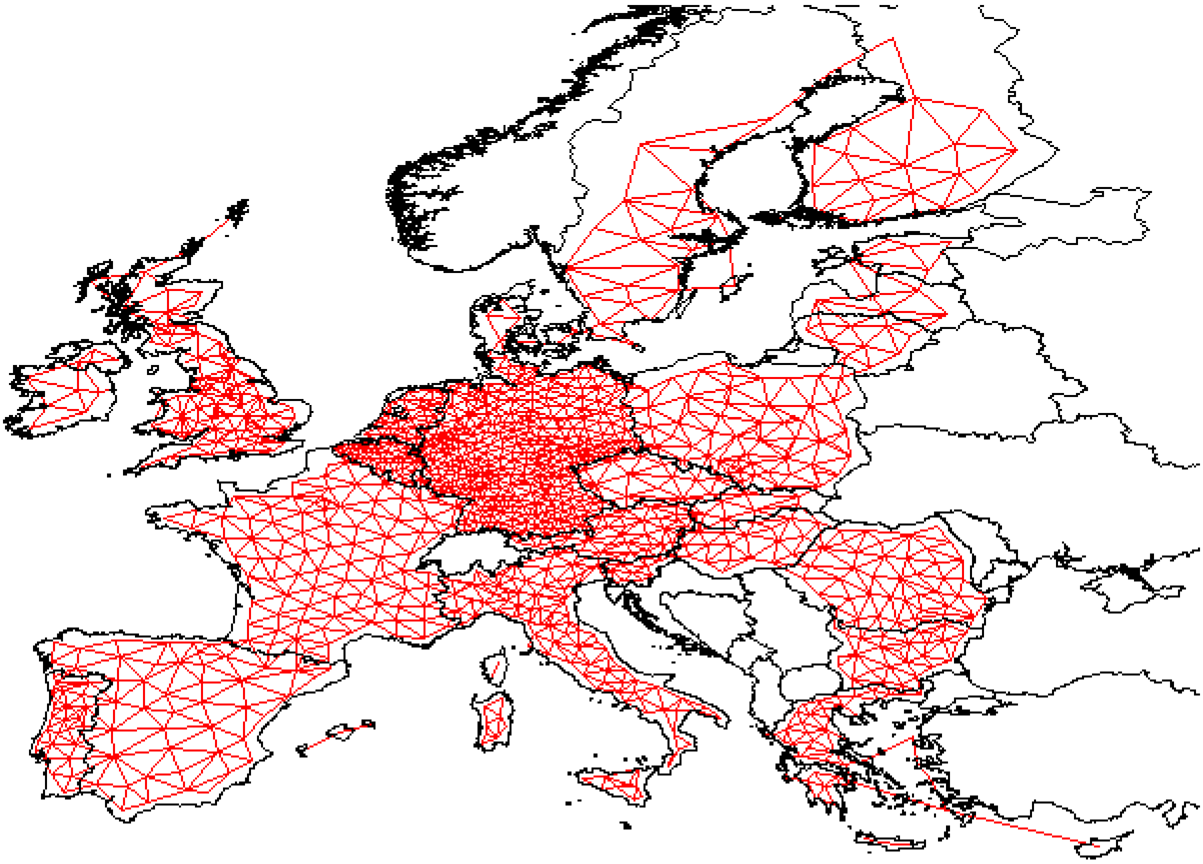
- $w_{ij}^*= 0$ if $i=j$ *and* if $j \notin N(i)$
- $w_{ij}^*= 1$ if $j \in N(i)$

N(i) is the list of neighbours of the region *i*, according to a first order queen contiguity matrix. According to the chosen approach, two regions are considered as neighbours if and only if they share a common boundary or vertex (Anselin, 1988). The queen contiguity matrix is chosen as our analysis is performed on NUTS 3 regions across the EU-27. Other spatial matrices (e.g., those based on the nearest neighbours) would create some major distortions in this kind of analysis[1]. A major issue, when dealing with contiguity matrices, is represented by islands: those regions clearly do not have any contiguous region. In our set of observations, 25 islands have been found: thus, they have been artificially connected to other regions according to both geographical and

[1] However, a distance matrix based on the 5 nearest neighbours has been used to check for robustness of results.

institutional proximity[2]. This adjusted contiguity matrix is shown in Figure 5. Non-zero links are 0.39% of the total number of links, and each region shows, on average, 5.04 neighbouring regions. In Table 1, the link number distribution is shown.

Figure 5. The first-order queen contiguity matrix



Source: own elaboration (software R – package spdep) (EuroGeographics for administrative boundaries)

Table 1. Link number distribution

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

Source: own elaboration (software R – package spdep)

According to the selected row-standardized spatial weights matrix (W), the global Moran's I statistics was first computed on the original variables. Then after the OLS estimation, we also test for spatial autocorrelation of the estimated error terms, by performing a Moran test on the residuals observed in (2).

[2] No other institutional elements have been taken into account: e.g., no distinctions have been made between trans-national neighbours and national neighbours. However, the authors are aware that national borders are still a central obstacles in analyzing the connectivity among regions. The same is true when considering neighbours sharing a mountains chain as a main boarder.

3.3. *Including the spatial effects*

After having tested the presence of spatial autocorrelation in the residuals observed from the OLS model in (2), we proceed by adding specification to the original model, also including spatial effects, until we get rid of the spatial correlation of the error term.

First, a spatial Durbin model is performed. This model just adds the neighbours' average values of the independent variables to the specification. Thus, moving from (2), the spatial Durbin model can be defined as:

$$Y = D\beta + X\gamma + WX\theta + \varepsilon \qquad (5)$$

where:

- Y is the intensity of RDP expenditures (expressed in terms of agricultural utilized area, agricultural labour force and agricultural gross value added);
- D refers to the list of 26 Country dummies (thus highlighting the *country effect*);
- X refers to the rural effect, expressed as above in three different ways;
- *W* is a spatial weight matrix, according to a row-standardised weight matrix – as shown in (4) – based on a first-order queen contiguity matrix.

Apart from potential problems of multicollinearity, this model poses no specific problems. The economic interpretation of the model is straightforward: as the amount a given region receives can also be affected by the extent of rurality within neighbouring regions, this model tests for the existence of both rural/rural competition and urban/rural cooperation in the allocation of RDP funds. Actually, different hypotheses of competition and cooperation are tested. After having tested this model, Moran test on residuals can be performed again.

Then, two more complex spatial models can be tested.

First, a Spatial Error Model (SEM model) is performed. In this model, the spatial influence just comes through the error terms. The model specification is the same that the one observed in the OLS model (2):

$$Y = D\beta + X\gamma + \varepsilon \qquad (6)$$

However, the error term specification is different, as it directly considers a spatial structure:

$$\varepsilon = \lambda W \varepsilon + u \qquad (7)$$

where:

- *W* is the row-standardised spatial weight matrix, as specified in (4);
- λ indicates the extent to which the spatial component of the errors is correlated with one another for nearby observations (as given by the spatial weight matrix).

This model helps in defining the so-called place (territorial)-based hypothesis. By considering a spatial structure in the error term, RDP expenditures are affected by the structure of the expenditures in neighbouring regions, too.

The last suggested model is a Spatial Autoregressive Model (SAR model). This model can partially take into account also the previous specifications. In particular, it implies that different levels of the *dependent* variable *Y* also depend on the levels of *Y* in neighbouring regions, according to the following definition:

$$Y = D\beta + X\gamma + \rho WY + \varepsilon \qquad (8)$$

where:

- Y is the intensity of RDP expenditures (expressed in terms of agricultural utilized area, agricultural labour force and agricultural gross value added);
- D refers to the list of 26 Country dummies (thus highlighting the *country effect*);
- X refers to the rural effect, expressed as above in three different ways;
- *W* is the spatial weight matrix, according to a row-standardised weight matrix, shown in (4).
- ρ indicates the extent to which the dependent variable is correlated with nearby values (as given by the spatial weight matrix).

The hypothesis tested here is that the spatially-lagged dependent variable can have a significant effect in explaining results: actually, this model implies that the levels of the *dependent* variable *Y* can depend on the levels of *Y* in neighbouring regions. As in the SEM model, a place-based hypothesis is included within this model, too. Actually, a comprehensive idea of spatial spillover is taken into account: the amount of money a given region is going to receive depends on the amount of money that neighbouring regions receive.

Both the SEM and the SAR model could properly take into account the spatial structure of data. Moreover, an additional model (that we are not going to test in the current paper) is represented by the general spatial model, combining both the SAR and the SEM model

$$Y = D\beta + X\gamma + \rho WY + \varepsilon \quad (9)$$

Where:

$$\varepsilon = \lambda W \varepsilon + u \quad (10)$$

4. RESULTS

Some preliminary analyses are performed on data about RDP expenditures within the NUTS 3 regions across the EU-27. When considering the intensity of expenditures (according to the utilized agricultural areas, the annual work unit and the agricultural GVA) some relationships with the extent of rurality clearly emerges. Actually, these intensity is strictly related with the extent of rurality however it is computed.

In Table 2, the Pearson coefficients linking together RDP expenditures with some definitions of rurality are first provided. When considering density, RDP expenditures are not significantly correlated to it. Just RDP expenditures per annual work unit are positively correlated with density (i.e., the more densely-populated the region, the more the expenditures' intensity). Significant correlations are found when considering expenditures' intensity and PR index. More central and urban regions (i.e., those characterised by lower PR index values) show a greater intensity of the RDP expenditures (with the only exception of expenditures per agricultural GVA).

Similar findings emerge when looking at the distribution of RDP expenditures per Eurostat typologies (predominantly urban, intermediate and predominantly rural regions). Urban areas generally show greater intensity than more rural regions (Table 3).

Table 2. Pearson correlation coefficients: RDP expenditures' intensity and different measures of rurality

	Density	PR Index
Expenditures per UAA	0.033 (0.245)	-0.023* (0.032)
Expenditures per AWU	0.091** (0.001)	-0.073** (0.009)
Expenditures per Agri GVA	-0.009 (0.760)	0.090** (0.001)

**, *: statistically significant at the 1%, 5%, respectively
Source: own elaboration on European Commission data

Table 3. Average RDP expenditures per urban-rural typologies

	EAFRD Expenditures		
	Expenditures per UAA	**Expenditures per AWU**	**Expenditures per Agri GVA (in millions €)**
Predominantly Rural (PR) regions	130.76	3,048.21	154.70
Intermediate (IR) regions	111.33	2,997.10	117.72
Predominantly Urban (PU) regions	101.07	2,625.86	89.82

Source: own elaboration on European Commission data

The correlation which is observed among the RDP expenditures' intensity and the extent of rurality partially hides a strong spatial autocorrelation. In order to detect it, the global Moran's I test is first performed. Table 4 shows the main results about spatial autocorrelation of the expenditures' intensity, by comparing two different spatial weight matrices: the first one is the above-mentioned matrix, based on a first-order queen contiguity matrix; the second one is a 5 nearest neighbours matrix (for each observation, the average values from the five nearest regions are taken into account). Both matrices suggest the relevance of significant spatial autocorrelation across EU observations.

Table 4. Global Moran's I statistics for the intensity of the RDP expenditures

	First-order queen contiguity matrix		5 nearest neighbours matrix	
	Moran's I	**p-value**	**Moran's I**	**p-value**
RDP Expenditures per UAA	0.4380	<2.2 e-16	0.4229	<2.2 e-16
RDP Expenditures per AWU	0.3682	<2.2 e-16	0.3693	<2.2 e-16
RDP Expenditures per Agri GVA (in millions €)	0.3513	<2.2 e-16	0.3457	<2.2 e-16

Then, the OLS model is estimated. Main results are provided in Table 5. The table does not show the estimations for the country dummies, just reporting the estimations for the rurality indexes as well as the results for the Moran test on the residuals. The full estimations of the model, including also the country dummies, is shown in Appendix A (effects on the RDP expenditures per UAA according to the definition of rurality based on the PR Index).

In particular, the PR index is negatively related to RDP expenditures per UAA, while it is positively related to RDP expenditures per agricultural GVA. On the opposite, density is positively related to intensity of expenditures, whereas the dummies about Eurostat typologies are not significant. According to these figures, however, it is easy to observe that the intensity of expenditures is greater in more central and more urban areas, whereas it is generally lower in more rural and peripheral areas. However, the Moran test on OLS residuals is significant for the estimated model, thus implying the presence of spatial autocorrelation that can affect the estimations.

Table 5. OLS estimation results (country dummies are not listed) (p-values in parenthesis)

	RDP Expenditures per UAA	RDP Expenditures per AWU	RDP Expenditures per Agri GVA (in millions €)
PR Index	-3.995**	66.71	4.612*
	(0.0088)	(0.2325)	(0.0466)
Moran test on residuals	0.208***	0.216***	0.204***
	(<2.2e-16)	(<2.2e-16)	(<2.2e-16)
Density	0.0155***	0.3529**	5.14e-03
	(1.57e-05)	(0.0056)	(0.294)
Moran test on residuals	0.215***	0.242***	0.222***
	<2.2e-16	<2.2e-16	<2.2e-16
Eurostat PR	1.147	141.2	14.6
	(0.846)	(0.527)	(0.13)
Eurostat PU	-3.435	-432.1	-25.24*
	(0.6126)	(0.091)	(0.0217)
Moran test on residuals	0.190***	0.216***	0.203***
	(<2.2e-16)	(<2.2e-16)	(<2.2e-16)

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

In order to get rid of the spatial correlation of the error term, a spatial Durbin model is tested. Main results are shown in Table 6. Clearly, the test on the Eurostat typologies' dummies are not performed. According to these results, the extent of peripherurality negatively affects the intensity of the RDP expenditures, whereas the extent of peripherurality in neighbouring regions positively affects it. These results largely confirm previous findings: urban and more densely populated areas show a greater RDP expenditures' intensity. However, the spatial Durbin model does not remove the spatial autocorrelation across residuals, which is still significant (according to the Moran test).

Table 6. Spatial Durbin model estimation results (country dummies are not listed) (p-values in parenthesis)

	RDP Expenditures per UAA	RDP Expenditures per AWU	RDP Expenditures per Agri GVA (in millions €)
PR Index	-12.74***	-281.08***	-7.553**
	(5.34e-12)	(3.18e-05)	(8.20e-03)
PR Index spatially lagged	22.41***	911.82***	31.387***
	(7.71e-16)	(<2.2e-16)	(2.66e-12)
Moran test on residuals	0.198***	0.175***	0.184***
	(<2.2e-16)	(<2.2e-16)	(<2.2e-16)
Density	0.031***	0.930***	0.028***
	(2.69e-13)	(3.02e-10)	(1.88e-06)
Density spatially lagged	-0.039***	-1.628***	-0.063***
	(2.66e-11)	(1.31e-13)	(1.00e-11)
Moran test on residuals	0.21***	0.225***	0.212***
	(<2.2e-16)	(<2.2e-16)	(<2.2e-16)

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

The last models directly take into account spatial effects: the SEM model includes them through the error terms, whereas the SAR model includes the spatially lagged dependent variables among the regressors.

The SEM model confirms the results obtained from the previous models: signs and coefficients do not change in comparison with other models: moreover the parameter lambda is highly significant, as indicated by the p-value (<2.2e-16) in all the estimations on the asymptotic standard error (Table 7).

Lastly, also the SAR model get rid of the spatial effects. The parameter rho is highly significant, too. Moreover, when testing for residual spatial autocorrelation after this model, this is found to be not significant (Table 8).

Table 7. SEM estimation results (asymptotic standard errors in parenthesis)

	RDP Expenditures per UAA	**RDP Expenditures per AWU**	**RDP Expenditures per Agri GVA (in millions €)**
PR Index	-10.362***	-205.49***	-5.213*
	(1.61)	(58.86)	(2.47)
λ	0.464***	0.480***	0.483***
	(0.032)	(0.031)	(0.031)
Density	0.027***	0.817***	0.024***
	(3.6e-03)	(0.13)	(5.0e-03)
λ	0.462***	0.493***	0.503***
	(0.032)	(0.031)	(0.030)
Eurostat PR	-1.879	64.08	5.45
	(5.69)	(212.01)	(9.20)
Eurostat PU	5.581	58.23	-11.30
	(7.11)	(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

Table 8. SAR estimation results (asymptotic standard errors in parenthesis)

	RDP Expenditures per UAA	**RDP Expenditures per AWU**	**RDP Expenditures per Agri GVA (in millions €)**
PR Index	-5.977***	-78.48	-0.775
	(1.41)	(51.17)	(2.13)
ρ	0.415***	0.447***	0.440***
	(0.032)	(0.032)	(0.032)
LM test for residual autocorrelation	0.292	6.905***	2.228
Density	0.019***	0.568***	0.013**
	(3.3e-03)	(0.12)	(4.5e-03)
ρ	0.417***	0.461***	0.454***
	(0.032)	(0.031)	(0.031)
LM test for residual autocorrelation	0.799	2.155	5.723**
Eurostat PR	-1.17	18.47	5.57
	(5.47)	(204.92)	(8.91)
Eurostat PU	1.78	-53.84	-11.73
	(6.30)	(234.95)	(10.14)
ρ	0.397***	0.434***	0.428***
	(0.032)	(0.032)	(0.032)
LM test for residual autocorrelation	2.150	10.391***	2.010

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

5. CONCLUDING REMARKS

This study sheds new lights on the main drivers affecting RDP expenditures allocation across the EU. In particular, this paper has tested the existence of both the rural and the pure spatial effect in such an allocation, by focusing on the 'local' allocation (i.e., at the NUTS 3 level) of RDP expenditures. Local allocation depends not only on the top-down decisions (which are eventually taken at some national or regional political level) but also on the bottom-up capacity to attract and use these funds.

According to the main results from this analysis, the rural effect does not show the expected sign. On the contrary, RDP expenditures' intensity is higher in more central (and urban) region. Thus, the analysis does not support the idea that the more rural a given region is the larger is the amount of RDP support it receives.

When directly taking into account the pure spatial effect, it plays a key role in defining the allocation of RDP expenditures across EU NUTS 3 regions. Different spatial models (the spatial Durbin model, the spatial error model and the spatial autoregressive model) have been tested and they strongly confirm the findings that have been previously obtained from a very general OLS model. Actually, the inclusion of the spatial effects does not remove the negative relationship between the extent of rurality (expressed in terms of both demographic density and PR index) and the RDP expenditures' intensity. Moreover, additional effects are observed: expenditures intensity in neighbouring regions usually play a significant effect in the obtained results.

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APPENDIX A

In the following table, the full estimations of the models (including also country dummies) are shown. In particular, just the model considering the RDP expenditures per UAA as dependent variable is shown. Moreover, in the following table, the definition of rural effect based on the PR Index is adopted.

Table A.1. Estimation results (standard errors / asymptotic standard errors in parenthesis)

	OLS Model	Spatial Durbin model	SEM	SAR
Intercept	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)
PR Index	-3.99**	-12.74***	-10.36***	-5.977***
	(1.52)	(1.83)	(1.61)	(1.41)
PR Index spatially lagged	-	22.41***	-	-
	-	(2.74)	-	-
λ	-	-	0.464***	-
	-	-	(0.032)	-
ρ	-	-	-	0.415***
	-	-	-	(0.032)
Moran Test on residuals	0.208***	0.198***	-	-
LM test for residual autocorrelation	-	-	-	0.292

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