

# **Are EU Rural Areas still Lagging behind Urban Regions? An Analysis through Fuzzy Logic**

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# OUTLINE

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- 1. Background & aim of the paper**
- 2. Quantitative approaches in defining rurality**
- 3. A fuzzy rurality indicator (FRI): methodology**
- 4. Describing EU rural areas**
- 5. Rural areas between backwardness and future challenges**
- 6. Concluding remarks**

# 1. Background & aim of the paper (i)

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- Rural areas and economic backwardness (e.g., circular cumulative causation, core-periphery models, New Economic Geography).
- Since the 80s, links rurality-economic backwardness have been questioned:
  - strengthening of medium sized towns in rural areas, supplying services (*Courtney et al., 2007; Courtney et al., 2008*);
  - diffusion of SMEs networks out of large cities (*Piore and Sabel, 1984; Brusco; 1989; Becattini, 1998*);
  - new infrastructures and ICT (*Castells, 1996*), reducing rural remoteness and fostering counter-urbanization processes;
  - diffusion of tourism (*European Commission, 1998*) and multifunctionality in agriculture (*Murdoch and Marsden, 1994*).
- Increasing heterogeneity among rural areas. Thus, new need for comparable definitions at international level.

# 1. Background & aim of the paper (ii)

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## ➤ Major aims of the paper:

1. Overcoming measures of rurality just based on density (e.g., OECD-Eurostat definition)
  - adopting a comprehensive indicator of rurality (multidimensional approach)
  - adopting a continuous indicator of rurality: several nuances in the EU urban-rural continuum can be defined
2. Contributing to debate on rural areas' backwardness. Is rurality still linked to specific socio-economic issues?

## 2. Quantitative approaches in defining rurality

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### What is a “rural” region?

- Evolutionary concept of rurality suggested by Sotte *et al.* (2012). According to *Post-industrial Rurality* framework:
  - New features: territorial dimension (urban-rural integrations) and polymorphism (different typologies of rural areas coexist)
  - New definitions: from OECD – EC approaches (*OECD, 1994; 2006; Eurostat, 2010*) to multidimensional approaches/multivariate analysis (*Lowe and Ward 2009; Anania and Tenuta, 2008; Terluin et al., 1995; Copus, 1996; Ballas et al., 2003; Vidal et al., 2005; Camaioni et al., 2013*)
- Here, a multidimensional approach is adopted. Thematic areas:
  - *Sector-based approach* (role of agricultural activities)
  - *Population-based approach* (population density)
  - *Territorial approach* (land use features)
- Major novelty: rurality is measured through Fuzzy Logic.

### 3. A fuzzy rurality indicator (FRI): fuzzy logic

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- Fuzzy logic (FL) is a mathematical approach reproducing human logic (Zadeh, 1965; 1968). No clear cut-offs to classify observations within well-defined classes. Single observations are linked to their probability of belonging to a given class (role of nuances).
- Boolean algebra is a typical binary logic (law of non-contradiction, law of excluded middle). FL handles the concept of partial truth: codomain of membership functions is the whole set of values within the closed interval  $[0,1]$ .
- Decision trees: complex decision-making processes are broken down into simpler decisions. Rules are set in natural language.
- A whole inferential system may be derived:
  - Designing the most suitable fuzzy system
  - Fuzzification of the inputs
  - Definition of if-then rules & inference (antecedent-consequent aggregation)
  - Defuzzification

### 3. A fuzzy rurality indicator (FRI): input variables

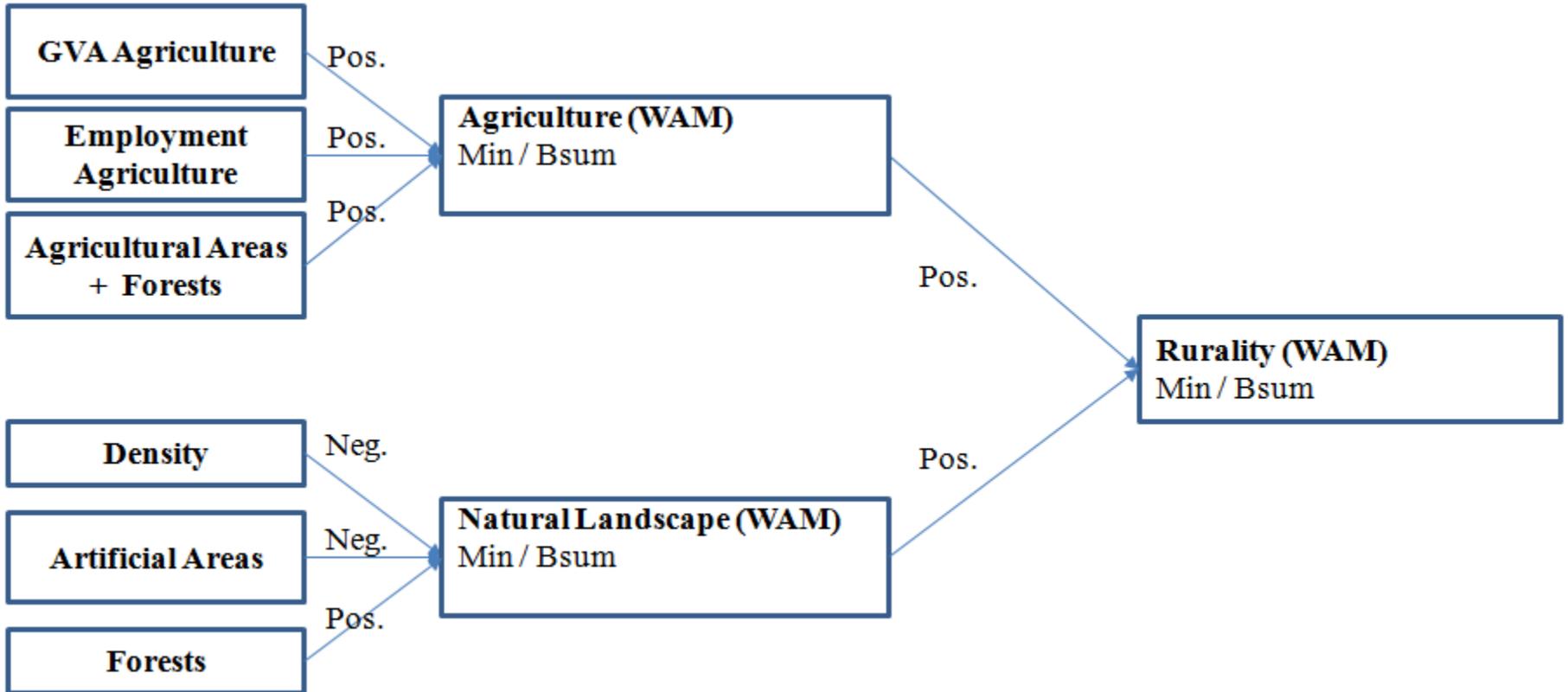
Territorial level of analysis: NUTS 3 level / EU-27 (1 288 observations).

#### *Input variables by thematic area*

	<b>Variable</b>	<b>Definition</b>	<b>Year</b>	<b>Source</b>
Sector-based approach	GVA Agriculture (%)	Share of GVA from sector A (NACE classification rev. 2) out of total GVA	2009	Eurostat
	Employment Agriculture (%)	Share of employment in sector A (NACE classification rev. 2) out of total employment	2009	Eurostat
	Agricultural areas + Forest lands (%)	Share of total surface which is covered either by agricultural areas or by forests and other semi-natural areas	2006	CORINE-Eurostat
Population-based approach	Population density	Ratio of the resident population on the total surface (in km <sup>2</sup> )	2010	Eurostat
Territorial approach	Artificial areas (%)	Share of total surface which is covered by artificial areas (urban fabric, industrial and commercial units...)	2006	CORINE-Eurostat
	Forest lands (%)	Share of total surface which is covered by forests and other semi-natural areas	2006	CORINE-Eurostat

### 3. A fuzzy rurality indicator (FRI): decision tree

*Fuzzy decision tree and signs of relationships*

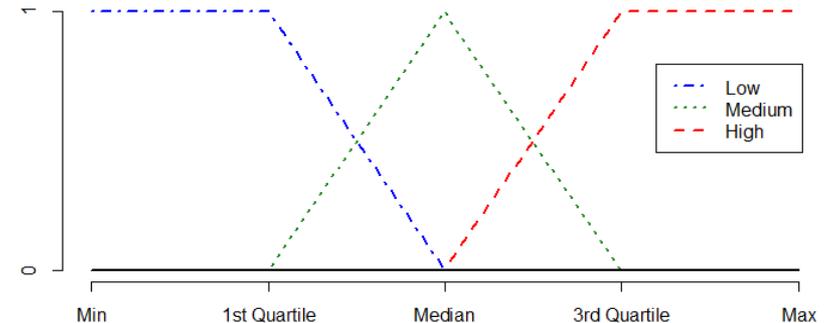


# 3. A fuzzy rurality indicator (FRI):

## membership functions, rule blocks

❑ **Fuzzification:** transforming input variables into grades of memberships for linguistic terms of fuzzy sets (e.g., low-medium-high).

A membership function is associated to each defined linguistic term: here, quartile distribution is used to shape them.



IF			THEN
Artificial areas	Forest Lands	Density	Landscape Indicator
Low	Low	Low	High
Low	Low	Medium	Medium
...	...	...	...
Low	High	Low	Very High
...	...	...	...
Medium	Medium	High	Low
...	...	...	...
High	Low	High	Very Low
High	High	High	Low

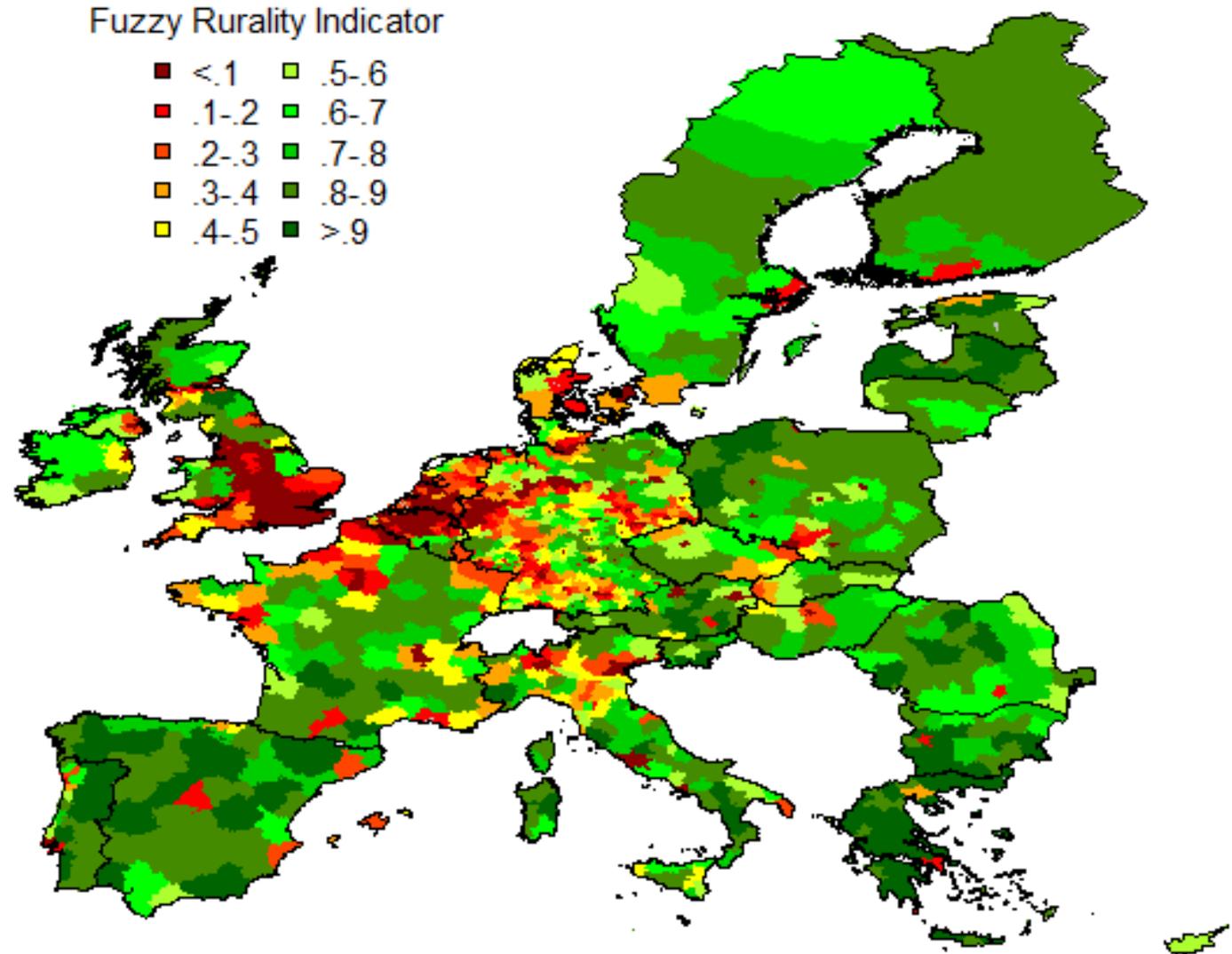
❑ **Rule blocks:** lists of linguistic control rules transforming input variables into a single output (inference).

They provide fuzzy numbers. Defuzzification restores crisp numbers.

## 4. Describing EU rural areas: a Nuanced Urban-Rural Continuum (i)

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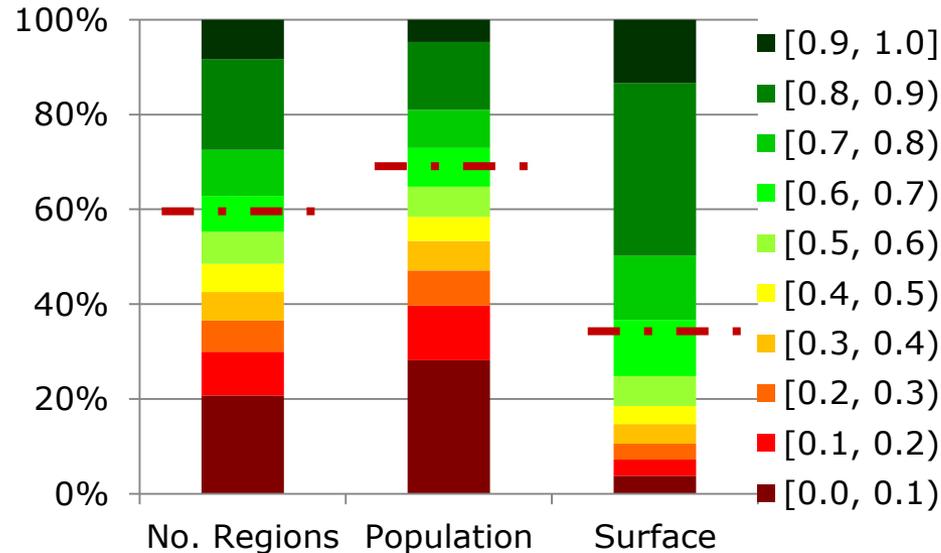
### *The Fuzzy Rurality Indicator*



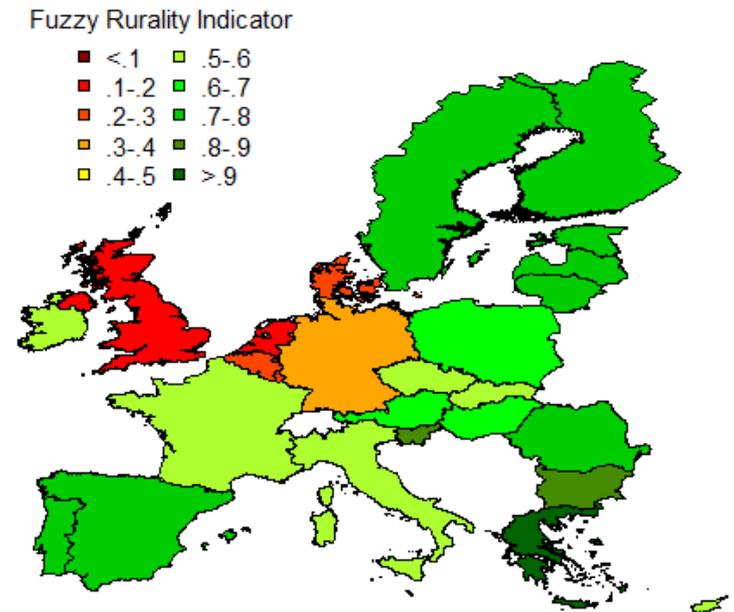
# 4. Describing EU rural areas: a Nuanced Urban-Rural Continuum (ii)

EU is (also) a rural continent....

*Cumulative distributions by FRI classes (EU-27)*



*Average FRI by Country*

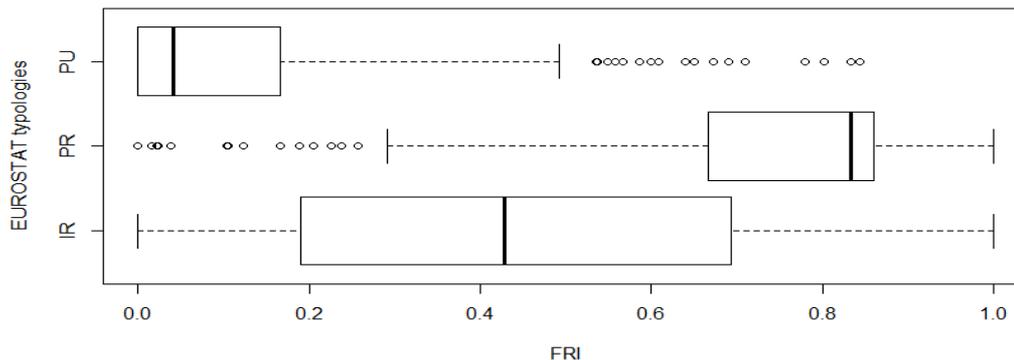


... some Countries are deeply rural!

## 4. Describing EU rural areas: comparing classifications

- Eurostat (2010) distinguishes: *predominantly rural* (PR), *intermediate* (IR), *predominantly urban* (PU) regions.
- FRI is a continuous indicator (urban-rural continuum)

*FRI values: distribution by Eurostat urban-rural typologies*



According to a One-Way ANOVA (Analysis of Variance): groups' average values are statistically different....

... BUT:

1. While PU and PR typologies are well shaped, IR is not (wider within-group variance)
2. Some NUTS 3 regions are classified in opposite ways.

# 5. Rural areas between backwardness and future challenges (i)

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Economic theory vs. Cases of rural success. Which are main strengths and weaknesses of rural areas?

Some questions. Compared to urban areas, are rural regions still characterised by:

- i. Weaker demographic trends?
- ii. Weaker economic development?
- iii. Lack of diversification of the agricultural sector?
- iv. Major remoteness from larger EU metropolitan areas?



These hypotheses can be tested by collecting socio-economic and other geographical variables.

- One-Way ANOVA (referring to Eurostat urban-rural typologies)
- Pearson correlation coefficients (referring to FRI)

# 5. Rural areas between backwardness and future challenges (ii)

## Long-term dynamics among urban-rural typologies

	EUROSTAT Urban-rural typology			Levene's test		One-way ANOVA		FRI
	PR	IR	PU				Person Correlation	
i. Population Growth (%)	-0.11	1.92	3.50	5.97*	29.69*	(0.000)	-0.14* (0.000)	
Aged dependency ratio	30.00	29.33	26.86	1.48	23.91*	(0.000)	0.07* (0.01)	
Net Migration Rate	-0.08	1.46	2.96	0.30	32.46*	(0.000)	-0.25* (0.000)	
ii. Per capita GDP (000 €)	18.57	22.21	27.10	9.76*	73.04*	(0.000)	-0.50* (0.000)	
Employment changes 2001-2007 (%)	3.64	4.39	5.26	11.20*	2.84	(0.059)	0.05 (0.079)	
Employment changes 2007-2009 (%)	-1.19	-0.47	0.01	18.82*	4.60*	(0.010)	-0.15* (0.000)	
Employment. Industry (%)	19.24	19.74	16.72	1.05	14.29*	(0.000)	0.09* (0.001)	
Employment. Services (%)	60.25	67.48	74.95	9.58*	188.80*	(0.000)	-0.57* (0.000)	
Unemployment Rate	8.79	8.29	7.77	5.28*	7.85*	(0.000)	0.19* (0.000)	
iii. Farm diversification	37.20	39.54	33.77	7.19*	12.52*	(0.000)	-0.01 (0.679)	
Average Farm Size	40.89	50.87	32.52	14.76*	17.57*	(0.000)	-0.09* (0.001)	
Average SGM	31.94	48.00	45.09	6.60*	21.23*	(0.000)	-0.31* (0.000)	
Touristic Bed-Places	97.36	66.46	32.71	31.59*	55.82*	(0.000)	0.24* (0.000)	
iv. Distance – Capital cities	282.3	295.3	268.0	14.27*	2.19	(0.112)	0.02 (0.464)	
Distance – Large cities	192.5	165.7	114.1	1.87	53.73*	(0.000)	0.39* (0.000)	

Negative demographic trends & Pop. ageing

Negative correlation between rurality and wealth. Weaker labour market indicators.

Farm diversification not correlated with rurality. Touristic activities positively related to the FRI.

Rurality & geographical remoteness

Statistically significant at 5%

## 5. Concluding remarks

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- ❑ The FRI: a comprehensive and continuous indicator of rurality at EU level.
- ❑ New picture of EU rural areas. EU is still a rather 'rural' continent and some groups of Countries show important rural traits.
- ❑ Latest socio-economic trends within rural areas:
  - ✓ socio-economic weaknesses still affect EU rural areas (e.g., depopulation trends and demographic ageing; low resilience in their labour markets).
  - ✓ New opportunities from the diversification of the agricultural sector (e.g., touristic activities).
- ❑ The debate on rural areas cannot be considered as completely over:
  - ✓ Large imbalances across EU rural areas
  - ✓ A strong stimulus towards more "place-based" and "place-aware" rural policies

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# Thanks for your attention

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