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Does infrastructure lift people's income?

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Abstract

This document questions the connection between infrastructure investment and GDP per capita across NUTS 2 regions in the European Union. Applying the fixed-effects regression model to the data extracted on Eurostat for a period of years, the research uncovers the fact that an increase in land used is associated with higher GDP per capita. This verification is subject to variations across regions and furthermore deepened through the elaboration of subtopics such as the impact of higher education on economic well-being and urban-rural per capita GDP comparison. The results obtained using Stata software suggest that investment in land used may contribute to economic performance in Southern and Northern Europe, and in regions defined as rural. Also, the impact of higher education on GDP per capita is observed predominantly in the Eastern and Western Europe.

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Introduction

Nowadays people suffer from countless problems may it be shelter, access to clean water, hunger, diseases, education, or unemployment. Of course, the density of the presence of these obstacles varies from one part of the world to another; nonetheless they can never be underestimated and must be elaborated to provide the best living standards to all people as much as possible.

If the world map is narrowed down to Europe to specify the topic, one of the keys to resolve the problem is studying the policies that governments have for their communities. The gap between the educated and illiterate, who has access to public transportation or not, living in urban or rural could all be the reasons that root for the income disparity among people. Thus, it can be easily recognized that there is a difference of income across European countries, which can be explained through the policies, and can be resolved through better economic performances.

In this context, this research will focus on the impact of infrastructure on people's income, GDP per capita representing the income, and to demonstrate if a connection exists between infrastructure and income. The experiment is conducted in the form of a panel structure. Three-year-data regarding the percentage of land used have been gathered for all the NUTS 2 regions of Europe. The corresponding GDP values have been put and then the analysis is conducted through the Stata software. The purpose is to see if the independent variable – along with the use of some control variables – is significant in justifying the GDP fluctuations across years for each NUTS 2 region.

The conducted analyses showed that the land used is a significant parameter in explaining the changes in GDP per capita. More specifically, the differences across Europe across regions such as North, South, East, West, Central have particularities, and the marginal impact of education and land used seem quite informative. Not only the geographical regions but also the marginal

effect on rural and urban territories can be elucidated, the welfare of the rural population can be improved following this analysis. Finally, the impact of the higher education on GDP per capita is also studied and a positive correlation has been observed.

Theory and Literature Review

The reagent under investigation is the relationship between infrastructure investment and the income in Europe. For the place of income, GDP per capita will be used. But what constitutes the GDP per capita? For this study the regional GDP per capita has been found on Eurostat with a factor PPS (Purchasing Power Standard), per inhabitant. PPS is an artificial currency unit which is used in the Euro area (a term used by Eurostat) and thanks to this unit one PPS can buy the same amount of goods and services in each country by adjusting for the price level differences using PPPs (Purchasing Power Parity). The formula is as follows:

$$\text{GDP per capita per NUTS 2 region} = \frac{\text{Regional GDP (in Euro)}}{\text{PPP conversion factor} * \text{Population}}$$

According to this formula, GDP per capita doesn't only depend on regional GDP but also on population. The population is inversely related with the GDP per capita.

For instance, the notably high GDP per capita seen in Luxembourg can be partly attributed to the significant number of cross-border workers like people commuting daily from France, Belgium, and Germany to work in Luxembourg. Although they contribute to the country's economic output, they are not included in the country's resident population. Consequently, though they increase Luxembourg's GDP, their consumption is registered in their home countries which leads to a discrepancy between economic production and domestic consumption [1].

A likewise case exists for Ireland too. The presence of multinational corporations boosts the GDP figures. These firms usually register intellectual property and manufacturing activities in Ireland for tax purposes, increasing

domestic production. However, a considerable amount of the profits generated are reallocated to foreign parent companies, and not to Irish residents, which means that the GDP per capita values may not fully show the actual income retained locally [1].

There are a couple of theories present in the literature which can be used to explain the phenomenon. The first one is the 'endogenous growth theory' and according to that "improvements in innovation, knowledge, and human capital lead to increased productivity, positively affecting the economic outlook" [2]. This theory underlines the role of technology in economic output and rejects the neoclassical point of view as it ignores the role of technology. This is compatible in explaining the impact of infrastructure on income as the infrastructure in this research refers to transport, telecommunication, energy distribution, storage, and protective works – as per Eurostat's use – and all of them have in some way a connection with technology. Transport requires the use of vehicles and roads which requires civil, mechanical, and automotive engineering, plus urban planning. Energy distribution covers a wide range of network such as electricity, gas, heating, renewable energy which all must be maintained functioning for the public through a solid engineering work, exploiting the use of technology. Storage covers energy, water, data, and logistics where both four can be linked to technology through the sensors for monitoring, and artificial intelligence for better estimation of the warehouse. Protective works include flood, seismic, and fire alert systems which can be linked to technology through the adoption of sensors.

The second theory that would be useful in explaining the connection between the infrastructure investment and income is the 'new economic geography'. It is defined as "The 'new economic geography' models the centripetal forces that foster geographic concentration and agglomeration against the centrifugal forces such as immobile factors (including land, natural resources, and people)" [3]. According to this theory, it could be said that urban areas profit

from the centripetal forces such as common infrastructure, knowledge spillovers, and the network of customers. However, in the rural, since these benefits are not present most of the time, the people heavily depend on land-based activities such as farming and husbandry. The use of the physical force and the use of knowledge obtained throughout years as a result of the studies could be the cause of income differences, and this could also be a topic of this empirical research. The definition done by Eurostat to define an area as urban is a region with a population of at least 5000 inhabitants and/or population density greater than 300 inhabitants/km^2 [4]. It is good to note that this definition is given for NUTS 3 regions. However, not to overcomplicate the research as the interest of the paper is on NUTS 2 so the same principal is adopted for NUTS 2 regions as well. It is very well known that there is a misbalance in the income levels of urban and rural, causing inequality. According to (An et al., 2011) this inequality could be diminished through the investment in transport infrastructure [5]. Another important fact is, in 2019, nearly 290 million immigrant workers took role in urban areas (CNSB, 2019) [5]. Most importantly, rural people's income increased in non-agricultural activities in China and wages become their top source of income after 2014, as per national statistics [5]. This is thanks to the increasing labour mobility through the exploitation of high-end transport infrastructure in China [5]. In the following chapters, the regions categorized as urban-rural will be analysed, through the marginal effect on GDP for an incremental increase in land used.

Moving on to the third theory which could be interesting in explaining the link between the choice of people to dedicate themselves into higher education and the intuitive result that has been obtained through the analysis. Before getting into the analysis in the following chapters, it would be useful to introduce the so-called 'human capital theory'. "A business executive invests in new equipment if the expected benefit derived from the equipment exceeds the cost. Human capital theory uses the same construct: an individual invests in education with an

expectation that the investment will provide a benefit in the form of higher earnings" [6]. Students have been studying for years to get a degree in the hope that in future they have a prosperous life, at least. However, this is for them to have a more rewarding job in future and with better working conditions. "We found that industrial land expansion was the leading factor for economic growth and emissions in developing regions, contributing 31% and 55%, respectively. Conversely, developed regions showed a diminished impact (8% and 3%, respectively), with a shift towards other economic growth drivers like education" [7]. As suggested by this data, it could be deduced that the regions having a decent percentage of highly educated people are expected to be less dependent on land used since the work being carried out is not mainly depending on physical work but more on a knowledge-intensive one where the use of land resources is not that essential.

Moving the attention from the theory to what has been said in the literature regarding infrastructure and GDP, Fedderke and Garlick (2008) after reviewing the empirical evidence in literature, came up with the conclusion that infrastructure has a positive connotation with productivity. Moreover, they found that GDP has a positive impact on airports' passenger levels but remarked that the analysis wasn't fruitful for electricity and rail. Nonetheless, according to the European Commission's econometric analysis, in the long run both transport and electricity infrastructures are both positively related with GDP. It makes sense as these infrastructures would stand firmly in long-run as there is no obsolescence for these infrastructures. The only issue is to maintain them functioning through periodic checks and maintenances, to provide the public an uninterrupted service. For what regards if GDP has an impact on the infrastructures mentioned vice versa, the European Commission Services demonstrated this through a graph. For electricity, there is a mutual relationship: the electricity infrastructure increases GDP, in turn there is need for a higher electricity capacity due to the increased

GDP. This is caused by for instance more apartments and businesses being built through the increased GDP, in turn a need for a greater electricity capacity

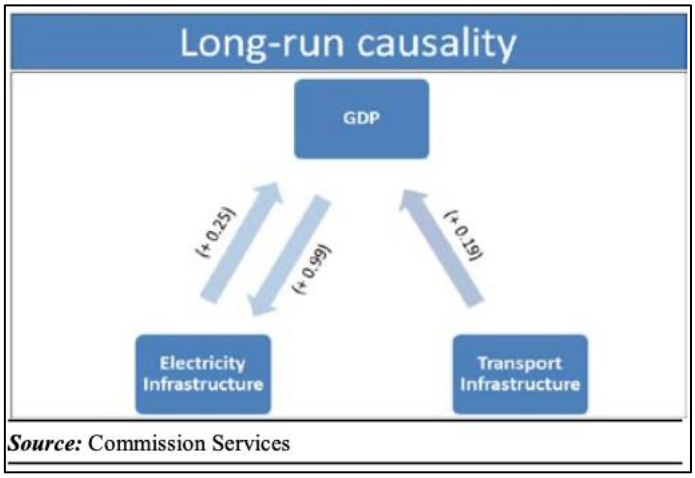

Figure 1: Long-term relationship between GDP and infrastructure stock [8]

becomes essential. Yang (2000) also shares this idea. Regarding the Chinese Taipei, he finds dual causality for GDP and electricity [9]. For transport infrastructure there is a unidirectional relationship: It induces higher GDP but with higher GDP there is not necessarily a need for more roads. This is mainly due to the fact that transport infrastructure projects are long-term projects which require political, planning, environmental, and sustainability approvals from the authorities [8]. However, there is the domino effect of road infrastructure that must not be forgotten: by investing in roads, not only the production and transportation costs decrease but also education and health are improved as the roads pave the way for the citizens to reach schools and hospitals. Consequently, people can get education and health services easily, making them aware of what is going on with their life and what kind of life they want to live. Thus, the impact of infrastructure investment on income and welfare of people can be seen: to reach the desired life, people could get a degree to work in the favoured destination which would provide them better life conditions [10].

Another important aspect to be mentioned is the Europe's dependence on road infrastructure. "Road networks account for rough 75% of EU inland freight

transportation and 90% of inland passenger traffic" [11]. Moreover, since the 1980s Europe had projects to provide adequate roads and highways which were mainly focused on Spain and Poland. The main purpose of the policymakers was to construct highways to support economic growth which would contribute to European economy altogether [11].

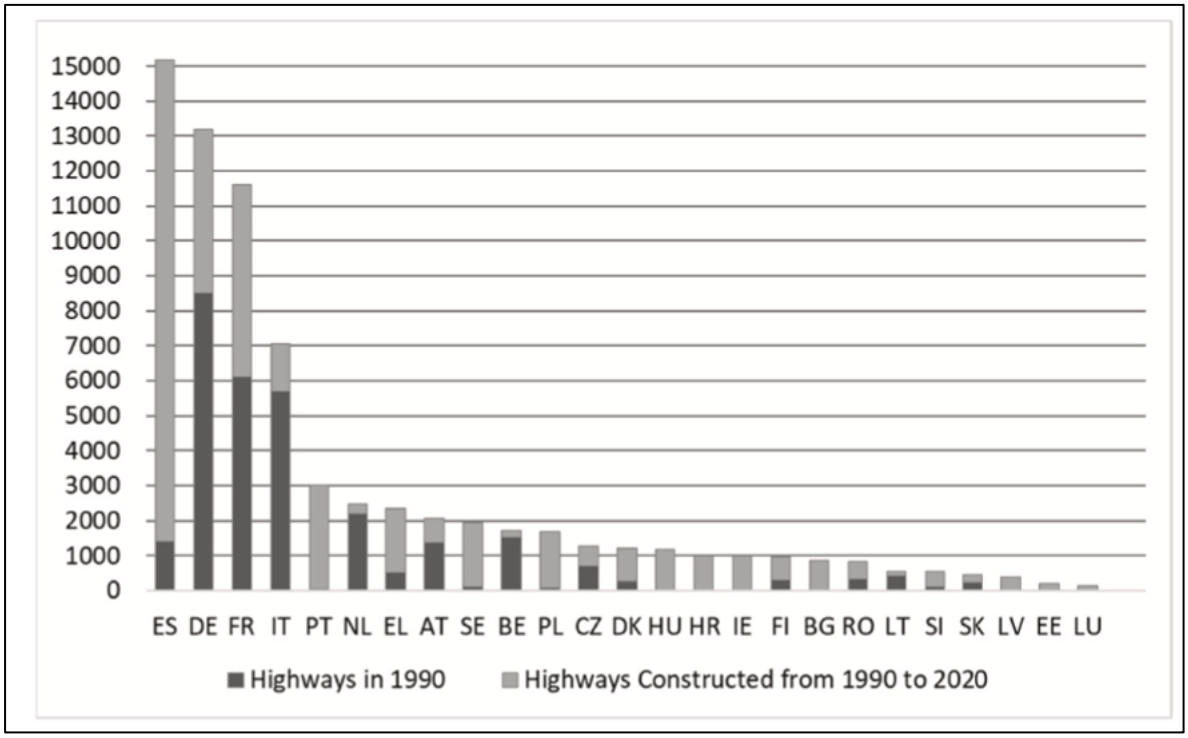

Figure 2: The length and construction of highways in the European Union, km [11]

This figure represents the highways built until 1990 and its comparison with the final condition in 2020. It can be realized easily that Spain surpassed all the countries within the 30-year-period, targeting the less developed regions. The country even had a period where the investment was at such a level that amounted to 1.8% of GDP on average during the 1997-2007 era. After Spain the biggest investments are made by Germany, Italy, and Poland; with Italy having a moderate increase, having built most of the highways up to 1990. Portugal, Greece, and Sweden are the countries trailing having a considerable development

in their highway structure [11]. The impact of these investments in terms of reduction in travel duration can be represented in the following table.

	Travel times	
	Mean	Std. Dev.
1990	14 h 16 min	9 h 26 min
2020	13 h 3 min	8 h 39 min

Table 1: Summary of travel times along European road and highway networks [11]

Table 1 sums up the median traveling times between the 227 EU regions for the 1990-2020 period, taking into consideration NUTS 2 regions. (It is important to note that there have been some additions to this list and as of today this number is equal to 242 [11]). As per what has been represented in the table, there has been a cut of 1 hour and 13 minutes for the mean travel time, which is equivalent to 8.6%. Also, a reduction of 45 minutes has been observed for the standard deviation amounting to 8% which leads to a greater decrease in travel times for farther destinations [11].

Moving on to what has been published for what regards telecommunication, Qiang (2009) and Qiang and Rosotto (2009) captured a powerful and compelling growth dividend from broadband access in developed countries. In high income countries, broadband penetration of 10 subscribers per 100 inhabitants is equal to 1.2% increase in GDP per capita growth [13]. Broadband penetration is for what degree the internet services are available for use to public. As more people become eligible to access, online businesses can be run. Moreover, people can access these markets easier with higher broadband penetration, increasing the trade and therefore the revenues of the companies. Not only constrained with trade but also people can add value to themselves through online educations which could in return help them be more productive. There are also other reasons which make telecommunication investment worthwhile: The

first one is that the projects can begin quickly and require a substantial amount of labour which increases the need for recruitment. Secondly, telecommunication investment, due to its structure, is a territorial investment but a sectarian spending could yield higher benefits to public as the money spent goes less to outer regions due to recruitment of local workers and contracting with local suppliers, creating working opportunities for the regional public. Thirdly, expanding the telecommunication networks to regions which don't have the adequate service; the impact could be more than developing the electricity, gas, water, and transportation networks as telecommunication networks opens new doors such as remote work, online shopping, and online businesses which increases the productivity of the region implicitly [13]. Stemming from this idea, a numerical example can be represented to introduce another point of view

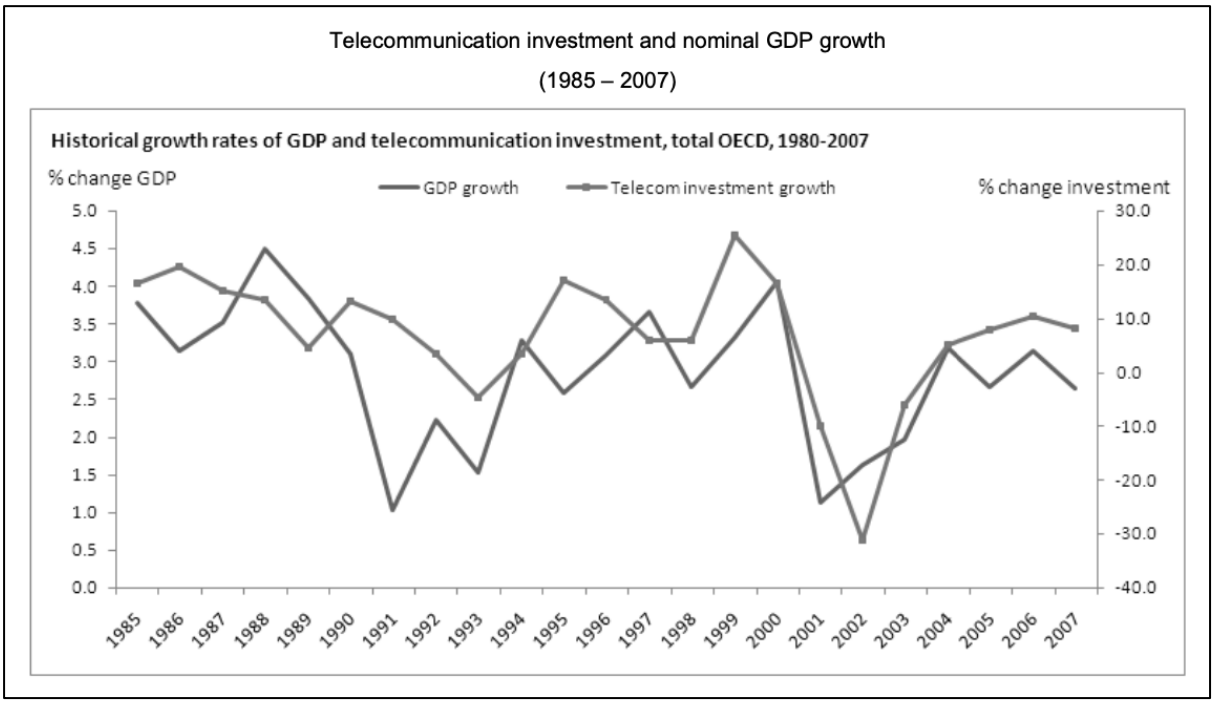

Figure 3: The sensitivity of telecommunication investment to economic growth [13]

regarding GDP and telecommunication investment. GDP growth hits a maximum of 4,5% and falls to a minimum of 1% whereas the delta in investment is augmented as opposed to GDP with a peak of 30% and a bottom of -30%. Here

GDP growth is the independent and the change in investment is the dependent variable as the period is a short term. In the long term an impact of investment on GDP is foreseen as well. It is important to point out that during the 22-year-period the trends follow each other with a 60% interaction, although the impact of GDP on investment is sharper. 1% delta in GDP is approximately equal to an 8% change in telecommunication investment. Thus, it can be deduced that the authorities tend to invest heavily – 8 times the GDP change – when the economy is thriving and cut the expenditure massively in the opposite case [13]. Ding and Haynes (2006) carried out a study and in the end, they concluded that the telecommunications infrastructure, measured by telephones per 100 people, is statistically significant and has a positive correlation with the regional economic growth in real GDP per capita in China. It is also important to mention that telecommunications investment is subject to decreasing return meaning that the positive correlation of telecommunications on GDP growth is greatest for regions with the minimum level of telecommunication infrastructure and the study found that keeping all else equal, backing with the conditional convergence hypothesis, regions with higher levels of GDP per capita are likely to grow at minor quotas in China. The public policy makers need to consider that to initiate growth in less-developed areas, hence an appropriate telecommunications infrastructure is essential to uphold economic advancement in those regions. It has been confirmed by this study that fixed investment, foreign direct investment, and employment rate have a positive impact on economic growth, whereas population growth has a negative impact [14].

Looking to what has been mentioned by the theories and in the literature, both go hand in hand, agreeing that infrastructure – transport, telecommunications, energy, storage, protective works – plays a central role in economic growth. To eliminate regional inequalities, investing in regions with less-developed infrastructure would result in substantial marginal impacts, which would close the gap with developed regions. Also, in the light of endogenous

growth theory, new economic geography theory, and human capital theory, this paper focuses on to bring forward numerical representations of the problems posed by the different percentile use of land across the European regions. Got informed thanks to the evidence presented in this section, this study assumes the following hypothesis: All else equal, an increase in land used in infrastructure is associated with an increase in GDP. By elaborating on this relationship, the aim is to provide a better understanding of this topic so that the policymakers can arouse growth across the regions.

Research and methodology

In this paper, the research type will be a quantitative one. This way it will be possible to demonstrate the impact of land used and other control variables on GDP per capita. To proceed with the experiment, it would be necessary to focus on the European countries, excluding the U.K., Norway, Iceland, and Switzerland as they are not part of the European Union.

There will be several analyses which are inspected under subgroups. First one is by geographic region. The research question to be answered is “how does the relationship between land used and GDP per capita vary across Northern, Southern, Eastern, Western, and Central European regions?” To do so, it would be handy to use three variables. Land used (I), GDP per capita (D), and regions (C). The EU countries have been subdivided into categories. Germany, Austria, Poland, Czechia, Slovakia belongs to Central; Estonia, Latvia, Lithuania, Denmark, Sweden, Finland to North; France, Belgium, Netherlands, Luxembourg, Ireland to West; Italy, Spain, Portugal, Greece, Cyprus, Malta to South; and Hungary, Romania, Bulgaria, Croatia, Slovenia to East. The parameters taken into consideration are obviously their geographical locations but also the culture they share and the habits they portray play an important role.

The second question that explores an outcome is by education level. The research question posed is “does the effect of land used and other socioeconomic factors on GDP per capita differ between regions with high vs low level of higher education?” Here it would be necessary to introduce a control variable for education to be differentiated as low level and high level, in addition to the previously mentioned independent and dependent variables.

Moving to the third question, research on urban vs rural will be conducted. The question that is being investigated is “is the impact of land used on GDP per capita stronger in urban regions compared to rural ones?” To be able to answer this question it is necessary to include another control variable to distinguish a

region as high-density or low-density. Here it is important to define the control variable population density per NUTS 2 regions which helps by defining a NUTS 2 region to be defined as rural if the population/km^2 is less than 300. It has been mentioned earlier that this simplification has been adopted as normally it would be necessary to introduce the NUTS 3 regions which would complicate the study.

In all the analyses, the fixed effects model has been chosen to be implemented to panel data. Countries have been handled and there are a lot of factors that is not in control such as the culture, the impact of the historical events' on today, etc. that could manipulate the results. It is not possible to be that precise in this study, defining that many parameters to obtain the best result, which is further beyond the scope of this study. To facilitate the experiment, it has been adopted the fixed-effects and not the random-effects which is much more straightforward with the accessible references.

The independent variable, as insinuated above, is the land used overview by NUTS 2 regions whereas the dependent variable is the regional GDP by NUTS 2 region. The control variables in action are population by education attainment level (less than primary, primary, and lower secondary education (levels 0-2), (tertiary education (levels 5-8)) which covers the age group of 15-64. The second control variable is population density by NUTS 2 region persons/km^2, the third one is the NUTS 2 regions, and the last one is year which covers 2012, 2015, and 2018.

These variables have been selected since they are crucial to study the current welfare of the European citizens. It is important to point out these differences per country to reduce the country-wise income inequality, even beyond, curtail the gap between the disparity for a resident in rural with respect to that of in urban. Of course, this passes through education, and it is an aspect never to be ignored. The impact of education level is also to be assessed to steer people towards education to pare the income inequality.

Thus, the aim is to understand the dynamics of Europe through the econometrics approach utilizing the variables mentioned. Are these variables sufficient to explain the income differences region-wise, population density-wise, and education-wise? They will be investigated over periods of 3-years, aforementioned as 2012, 2015, and 2018.

Data collection

As it was acknowledged in the previous section, the focus of this research is based on the countries in Europe, more specifically, in the European Union. The 27 countries are as follows: Austria, Belgium, Bulgaria, Croatia, Republic of Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, and Sweden. The countries to be addressed have been selected as the E.U. because although they share a reconciled institutional framework, the income differences are evident in NUTS 2 regions, which is a standardized nomenclature across Europe. If this study were based on a more global scale the data accessibility and comparability would have been much more difficult, which is alleviated, thanks to NUTS 2 nomenclature of Eurostat.

The observations are to be obtained using variables mentioned which are: Land used, regional GDP per capita, population education attainment levels, and population density. Land used is the independent variable which will serve as the measure of infrastructure investment. Regional GDP per capita is the dependent variable which is the resultant to be explained with the independent and control variables. It reflects the average welfare of each NUTS 2 region through the value added obtained by production of goods and services in a country during a certain period [14]. It could be a topic of discussion whether education has a greater impact than population density on income. It must not be forgotten that the geographical differences, meaning classifying a country in West, East, North, South or Central Europe, that neither consider the education nor the population density, could also be an implicit justification. The work culture of the regions, their topography, climate, and the presence of industry or tourism opportunities in a region could account for the income gap.

Figure 4: Countries of the European Union [16]

Below this paragraph a review of the variables and how they are going to be measured can be reached. All of them have been obtained through the dataset of Eurostat with the given unit of measure, and their types. It could be interesting to address why these variables have been selected to explain this phenomenon? In fact, the data have been selected with multiple times, meaning multiple years, along with multiple units, in the form of panel data, to better assess the change. It is noteworthy that there have been additional variables in the dataset such as net migration, total population change, natural change of population, and population on January 1 which were imagined to be useful during this research but were not fruitful in the end.

Variable	Unit of measure	Symbol	Type	Source
Land Used	%	LU	Independent	Eurostat
GDP per capita	PPS	GDPpc	Dependent	Eurostat
Education Level	%	EL	Control	Eurostat
Population Density	Person/km^2	PD	Control	Eurostat

Table 2: Description of the variables

When the distribution of the variables is observed, an important remark is the homogenous picture present in the table. As it can be seen, there is one independent, one dependent, and two control variables. It is noteworthy to say that there are two types of education parameters, one is to represent tertiary education the other is the remaining (primary and lower secondary education). The purpose is to create links between the income, which is represented through the dependent variable GDP per capita, and the independent variable, which is land used. Any mediator variable that could be useful to create connections between the two and to create comparability among them has been used in this paper.

Regression equations

Before moving to the regression equation, it is necessary to define what regression means. According to Kenton, regression is a statistical method that attempts to establish a relationship between a dependent variable and one or more independent variables [17]. The important thing about regression is that the connection is quantified, in terms of coefficients, standard errors, and whether the confidence interval is satisfied or not. In turn, the hypothesis, meaning the existence of the relationship, can be accepted, or rejected. The significance of the variable comes out from this section, whether a subregion needs to be considered or discarded.

Mainly there are four analyses that have been conducted. They have been categorized according to the equation number indicated between parentheses as follows:

1- Overall regression to decide which variables would be useful for this experiment (1)
2- GDP per capita by regions:
    - Calculation of marginal increase in GDP per capita per regions (2)
    - The equation used for computing each region's marginal increase in GDP per capita with respect to the base region chosen (3)
3- Urban vs Rural comparison:
    - First model for measuring marginal impact (4)
    - Second model for measuring the marginal effect of rurality on GDP per capita for each NUTS 2 region (5)
4- Education level:
    - Overall regression for measuring the marginal impact of higher education on GDP per capita across European Union (6)
    - The effect of marginal increase in land used for high education regions (7)

- Marginal increase in GDP per capita associated with higher education for the five European regions (8)
- Expanded version of the previous equation (9)

Data analysis

Overall regression

The first model includes all the variables that have been thought as useful for the purpose of this research. It could be, if not the most, one of the most important regressions computed because stemming from these results the variables to be analysed individually have been chosen.

$$GDPpercapita_{i,t} = \alpha + \beta_1 \cdot LandUsed_{i,t} + \beta_2 \cdot EducationLevel02_{i,t} + \beta_3 \cdot EducationLevel58_{i,t} + \beta_4 \cdot NetMigration_{i,t} + \beta_5 \cdot TotalPopulationChange_{i,t} + \beta_6 \cdot NaturalPopulationChange_{i,t} + \beta_7 \cdot PopulationOnJan1_{i,t} + \beta_8 \cdot PopulationDensity_{i,t} + \varepsilon_{i,t}$$

(1)

It should be noted that there are two subscripts. The one “i” refers to the region and “t” refers to the time which is the year.

Variable	Coef.	Std. Error	t	P >|t|	[95% Conf. Interval]
LandUsedbyNUTS 2regions	613.94	105.1701	5.84	0.0	(407, 820)
EducationLevels 0–2	-45.93	31.0796	-1.48	0.14	(-106, 15)
EducationLevels 5–8	345.21	45.9148	7.52	0.0	(254, 435)
Net migration + stat. adj.	1096.77	2185.107	0.5	0.616	(-3196, 5390)
Total population change	-483.69	2183.151	-0.22	0.825	(-4773, 3805)
Natural change of population	1022.99	2193.847	0.47	0.641	(-3287, 5333)
Population on Jan1 (person)	-0.0009	0.001799	-0.53	0.59	(-0.002, 0.0004)
Population density (person/km²)	0.857	0.5814773	1.48	0.141	(-0.28, 2)
_cons	16708.5	1634.289	10.22	0.0	(13497, 19919)

Table 3: Regression output for all the selected variables

As it can be seen the variables with the corresponding coefficients, standard errors, t values, the probability that the coefficient is zero assuming that the hypothesis true, and finally the 95% confidence interval. If the probability is less than 5%, it can be deduced that the coefficient is statistically significant.

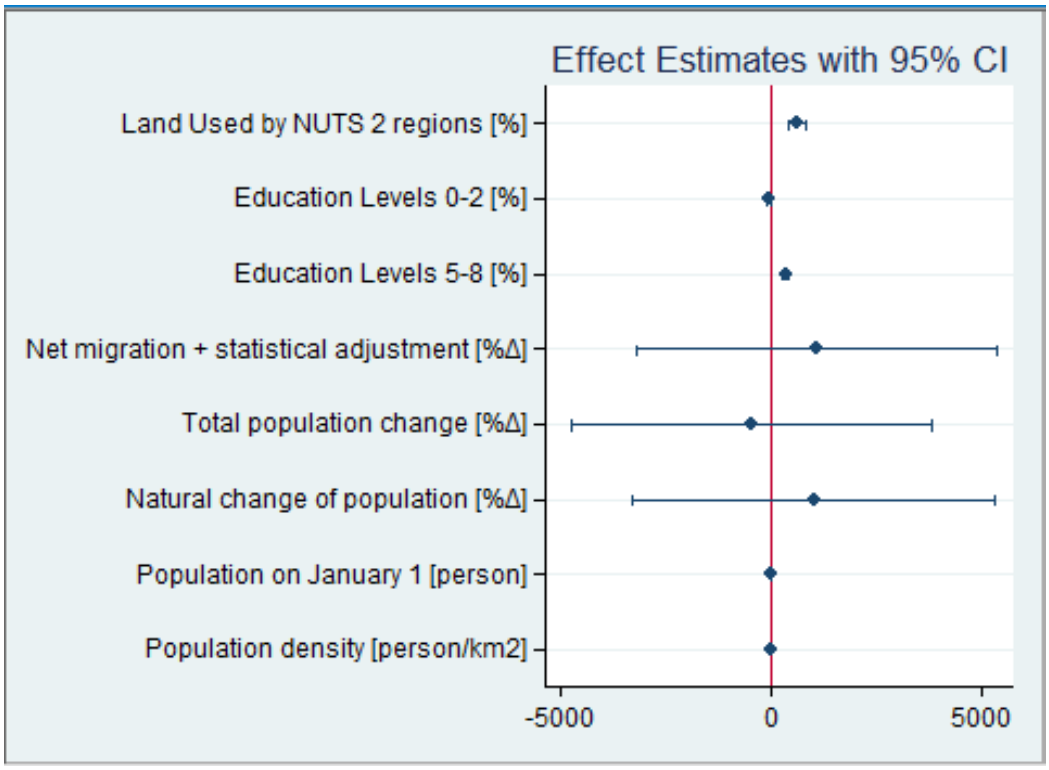

Figure 5: Confidence intervals of the variables

This figure better illustrates the data on the table, visually. The dots show the estimated coefficients. The first thing to be checked is if all the coefficients are within the 95% confidence interval. For this case this condition holds for all of them as the horizontal lines represent the confidence intervals. The second is if the red vertical line crosses the confidence interval as the red vertical line represents no effect (i.e., the null hypothesis: coefficient being equal to 0). Vice versa if the vertical line doesn't cross it, the effect is statistically significant at 5% level. This is true only for "Land Used by NUTS 2 regions" and "Education Levels 5-8" variables. Without the use of this figure this can be interpreted by the probability p being below 5%. This regression helps to eliminate the variables which wouldn't be fruitful for this study. However, although population density resulted insignificant, it has still been considered but in a different manner. It will be detailed in the urban-rural part.

GDP per capita by five European regions

Average GDP per capita

The second model tries to measure the comparison of the impact of "Land Used by NUTS 2 regions" and "GDP per capita" among the five European regions. For this end, initially, as mentioned above, the partition of Europe has been realized as North, South, East, West, and Central.

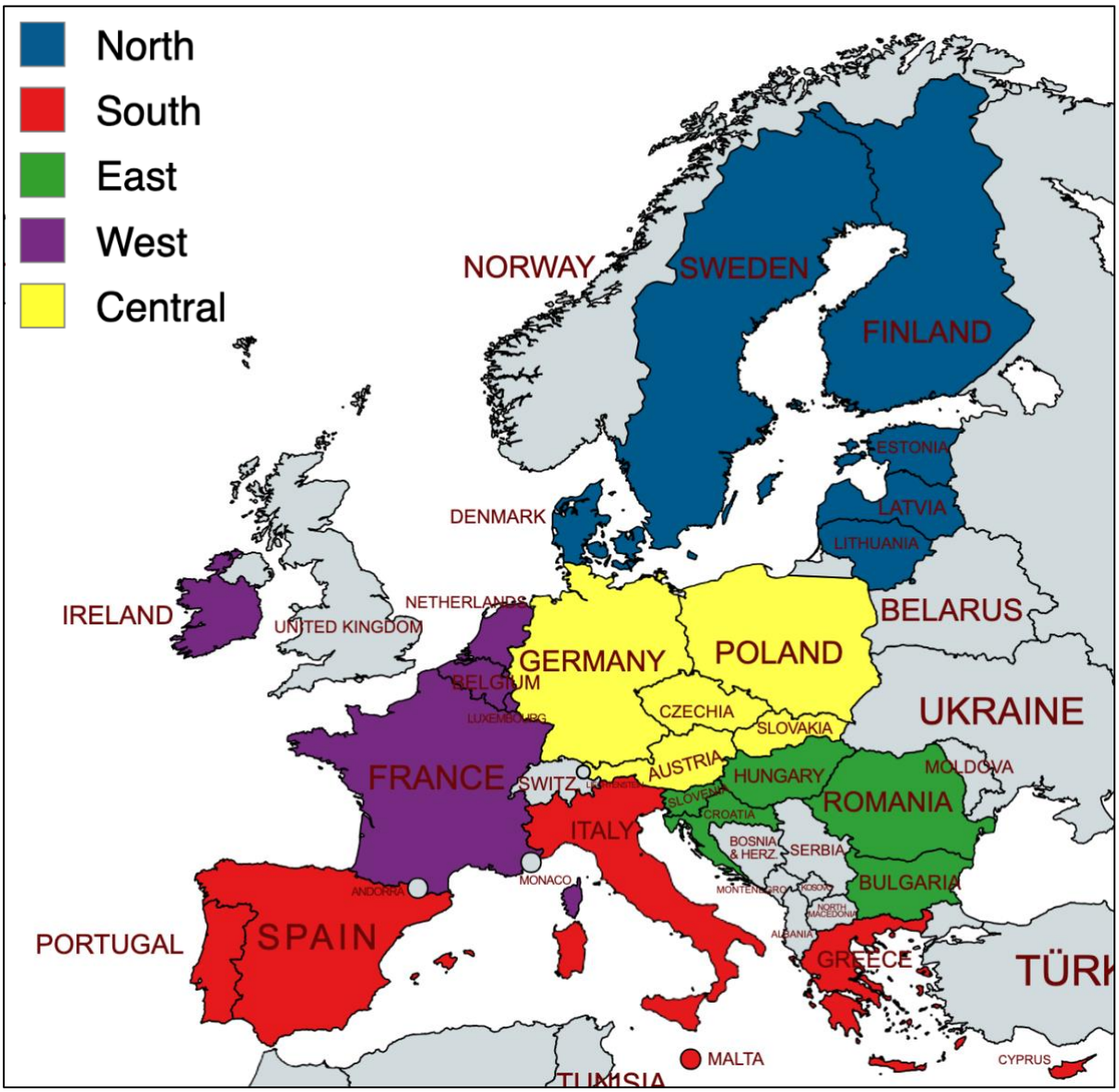

Figure 6: Partition of European Union countries into five categories [18]

This partition would allow to better represent the like-cultured countries' incomes as per their use of the land.

The first analysis conducted on Stata has been regarding the average GDP per capita by each region. The purpose of this is to be used in the calculation of the final GDP per capita after computing the marginal impact.

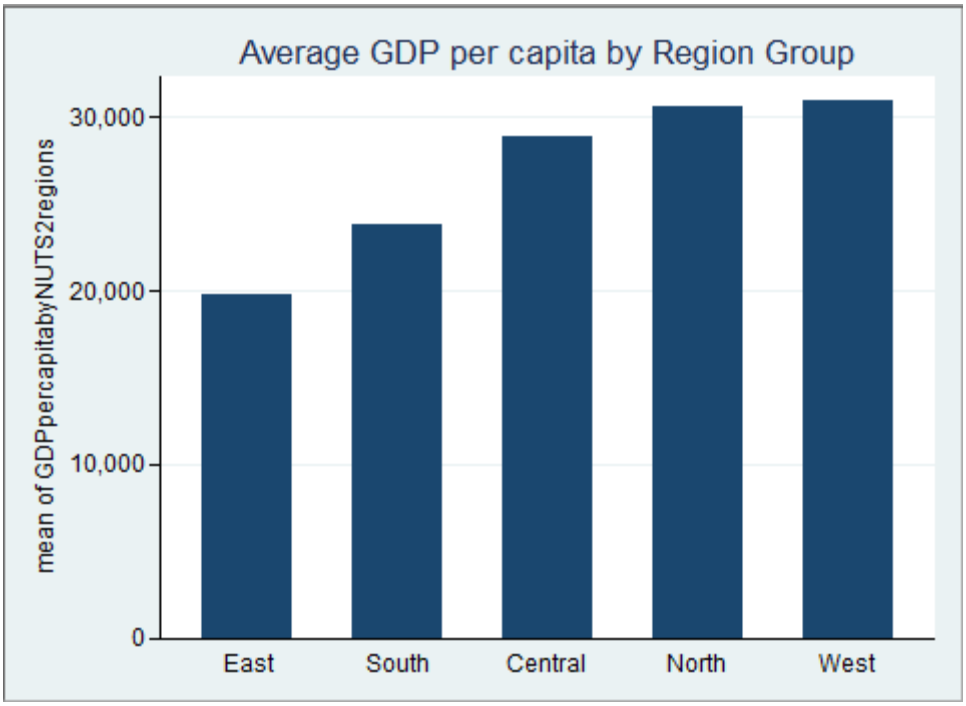

Figure 7: Average GDP per capita by region

As can be seen, the highest GDP per capita belongs to the West whereas the lowest is observed for the East. The average GDP per capita for each region is as follows:

1- West: 30,960.28 PPS
2- North: 30,621.21 PPS
3- Central: 28,917.54 PPS
4- South: 23,801.79 PPS
5- East: 19,848.15 PPS

The most prominent observation is the income gap between West and East, which is quantified as 11,112.13 PPS which accounts for more than half of the average income in East. Another interesting fact also comes from an opposite direction: The average wage differences for North and South is 6,819.42 PPS. In this case the gap is not that high but still more than a quarter of the income in the

South. The Central region demonstrates an intermediate position, which is closer to the West and North.

It is not surprising that Western Europe is leading as Luxembourg and Ireland are the top two countries, Luxembourg with an average GDP value around ≈ 76,000 PPS and 43,000 PPS respectively. Then comes Croatia representing the East with ≈ 37,000 PPS and they are trailed by Austria and Germany from the Central with ≈ 35,000 PPS and ≈ 33,000 PPS. The first two countries from the North are Denmark and Sweden with very close PPS values ≈ 33,000. The final observation worth mentioning is the first two flag holders of the South are Malta and Italy with average GDP per capita values ≈ 27,500 PPS. These data are explanatory for the fact that the West is the leading region whilst the East is the last region as after Croatia there is a long way for the East region in terms of GDP per capita in PPS. The full ranking of the table can be found in the appendix section.

Marginal GDP per capita

This section tries to measure the impact of a marginal increase in Land Used on GDP per capita by each region. The regression equation is as follows:

$$GDPpc_{i,t} = \alpha + \beta_1 \cdot LandUsed + \beta_2 \cdot Region + \beta_3 \cdot (LandUsed \times Region) + \varepsilon_{i,t} \quad (2)$$

To calculate the marginal effect, the following equation can be utilized:

$$\text{Marginal Effect} = \beta_{LandUsed} + \beta_{Regioni \times LandUsed} \quad (3)$$

Region	Base Effect (β_1)	Interaction Effect (β_3)	Marginal Effect (PPS)	Significance (p-value)
Center	299.01	–236.03	62.98	0.047 (borderline significant)
East	299.01	142.57	441.58	0.261 (not significant)
North	299.01	827.84	1126.85	0.030 (significant)
South	299.01	1397.01	1696.02	0.000 (highly significant)
West	299.01 (baseline)	—	299.01	(reference group)

Table 4: Marginal effect of GDP per capita

As also represented by the graph, the highest marginal effect is seen in the South whereas the lowest is observed in the Central. Moreover, the value of the East is considered as not significant due to the fact the p-value exceeds the limit of 5% with a percentage of 26.1%, not making it useful data. The data still can be ranked:

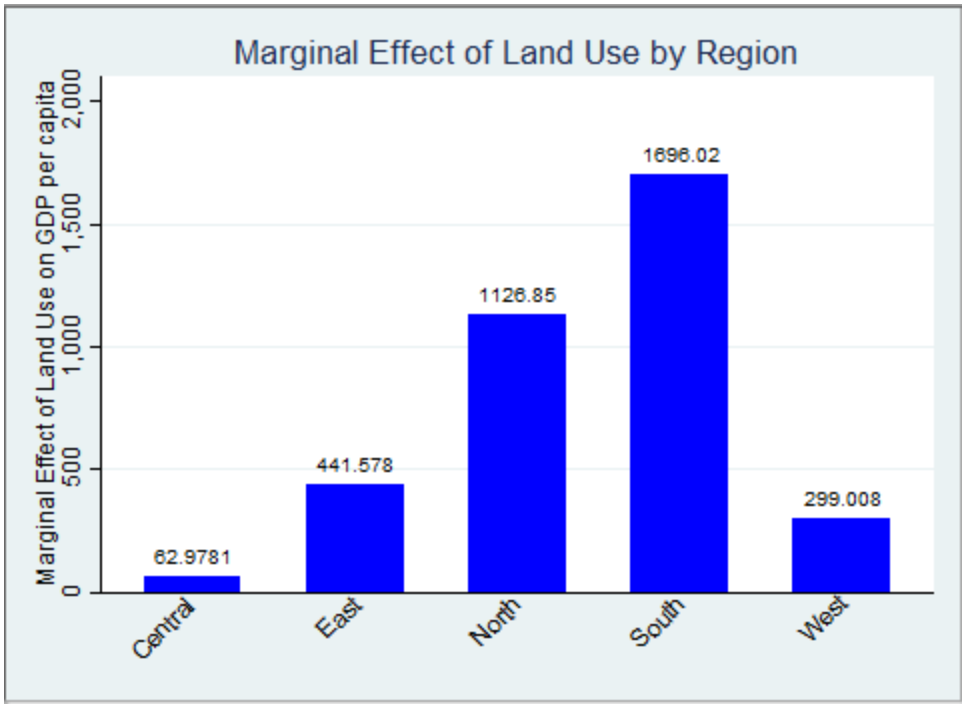

Figure 8: Marginal Effect of Land Used by region

These data indicate the fact that the South and North are the regions that are open for infrastructure investments, as they demonstrate an increase over 1,000 PPS per annum. When it comes to the East, this region still shows a need to invest. However, the same can't be stated for the Central region as the increase is infinitesimal compared with its average GDP, which is ≈ 31,000 PPS. These regional disparities may reflect differences in land productivity, infrastructure investment efficiency, or urbanization patterns. For the East, although the effect is positive, it is statistically insignificant thus it can be deduced that there are structural inefficiencies that cause this inefficiency and/or diminishing returns due to land used policies.

Cumulative GDP per capita

This ultimate section of this part tries to demonstrate the final GDP per capita by incorporating the average and marginal values. The purpose is to see if the marginal impacts would change the rankings of the regions and percentage increases for each region compared to the previously calculated averages.

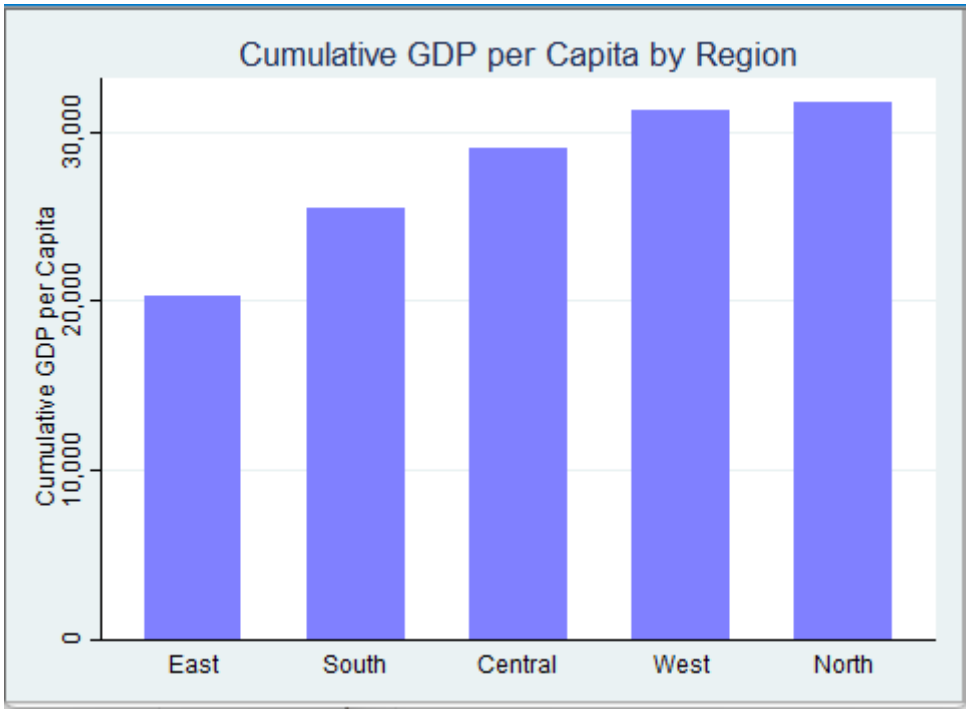

Figure 9: Cumulative GDP per capita by region

The most outstanding observation is the fact that the ranking has changed. Previously, the West had the highest average GDP, however after studying the marginal GDP per capita, the North surpassed the West. The other regions' rankings remained the same. It would be useful to represent the changes in a table to better illustrate the magnitude of the differences in marginal GDP per capita.

Region	Average GDP per capita (PPS)	Marginal GDP per capita (PPS)	Final GDP per capita (PPS)	Increase
Central	28,917.54	63	28,980.52	0,22%
East	19,848.15	441.58	20,289.73	2,22%
North	30,621.21	1,126.85	31,748.06	3,68%
South	23,801.79	1,696.02	25,497.81	7,13%
West	30,960.28	299	31,259.29	0,97%

Table 5: Increase in average GDP per capita by region

The highest increase is observed for the South region, however the lowest is seen for the Central. The low increases can be related to the diminishing returns as the Central and West regions have already been using the land efficiently thus, they would undergo smaller GDP gains. Under-developed regions like the South and East would yield higher marginal GDP gains from additional investments in infrastructure reinforcing the idea of catch-up growth. It is defined as "catch up effect, alternatively called the theory of convergence, states that poor or developing economies grow faster compared to economies with a higher per capita income and gradually reach similarly high levels of per capita income. This theory of convergence of incomes is based on the logic of better opportunities of growth available for developing economies like access to technological know-how from the developed world and increasing returns to capital, etc" [19].

GDP per capita: Urban vs Rural regions

First model

This section is the one that has required an utmost attention to details. To start off, the variable "Population density per km^2" has been chosen to advance. According to this variable, as mentioned in the theory and literature review section, the definition done by Eurostat to define an area as urban is a region with a population of at least 5000 inhabitants and/or population density greater than 300 inhabitants/km^2 [4]. The results obtained assuming this definition is as follows:

$$GDPpc_{i,t}=\alpha+\beta_{i,t}\cdot(Urban\times LandUsedbyNUTS2regions)_{i,t}+\varepsilon_{i,t} \quad (4)$$

Area Type	Base Effect (Land Used)	Interaction Effect (Urban × Land Used)	Marginal Effect (PPS)	Significance
Rural	533.21 PPS	—	533.21	Significant (p = 0.000)
Urban	533.21 PPS	–488.42 PPS	44.79	Significant (p = 0.000)

Table 6: Marginal Effect calculation

As a result, the marginal impact of investing in land in a rural area is 533 PPS whereas in an urban area it is 45 PPS. This can be explained by several factors. Since in urban areas the land has already been used, there are not as much space as the one in rural areas to invest. Moreover, the development potential, type of growth, return on land used, and regulations differ for both. It makes the development more in favour of rural areas, usually.

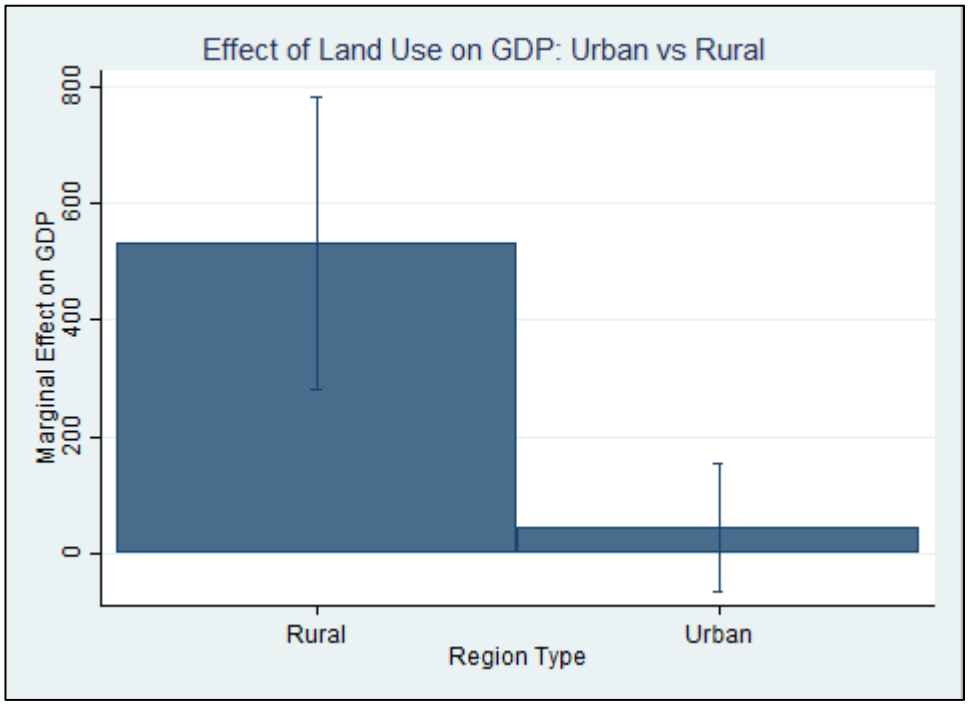

Figure 10: Urban vs Rural GDP per capita comparison

This figure demonstrates visually the confidence interval and the marginal increase in GDP per capita. The huge gap between the rural and urban is displayed in this figure. Though, the problem with this method is that it works for NUTS 2 regions. The definition given by Eurostat is for NUTS 3 regions, so this method must be updated with a more accurate one, proper and adapted to the definition. To this end, a new method is going to be introduced.

Second model

This version of the analysis considers the use of NUTS 3 regions. Each of NUTS 2 regions' subregions which are referred as "NUTS 3 regions" are written next to it with the corresponding binary that represents if its rural or urban. In fact, there are three numbers which have been used: 1 represents urban, 2 represents intermediate, and 3 represents rural. For this study, the NUTS 3 regions that only have the number "3" next to them are considered as rural, the intermediates are discarded. Then, the percentage of rurality of each NUTS 2

region is decided by taking the ratio of the total number of its rural NUTS 3 subregions divided by the total number of its NUTS 3 subregions.

NUTS 2	NUTS_ID	URBAN RURAL CATEGORY	Rural Regions	Total Regions	Ratio of Rural/Total	GDP per capita 2016
Piemonte	ITC11	1	3	8	38%	29500
	ITC12	2				
	ITC13	2				
	ITC14	2				
	ITC15	2				
	ITC16	3				
	ITC17	3				
	ITC18	3				
Valle d'Aosta/Vallée d'Aoste	ITC20	2	0	1	0%	36000
Liguria	ITC31	1	0	4	0%	30700
	ITC32	2				
	ITC33	1				
	ITC34	1				
Lombardia	ITC41	1	1	12	8%	37100
	ITC42	1				
	ITC43	1				
	ITC44	2				
	ITC46	1				
	ITC47	2				
	ITC48	2				
	ITC49	2				
	ITC4A	2				
	ITC4B	3				
	ITC4C	1				
	ITC4D	1				
Abruzzo	ITF11	3	1	4	25%	24100
	ITF12	2				
	ITF13	2				
	ITF14	2				
Molise	ITF21	3	2	2	100%	19800
	ITF22	3				
Campania	ITF31	1	1	5	20%	18100
	ITF32	3				
	ITF33	1				
	ITF34	2				
	ITF35	2				

Figure 11: Rural region calculation method

This method can be thought of as a derivative. Since the focus of this study is not NUTS 3 regions, but instead NUTS 2 regions, the rurality of each NUTS 2 region is derived from its subregion here indicated as "NUTS_ID". Then, as seen by the example above which represents Austria, the sum of the rural subregions is divided by the total number of subregions in that region to obtain the rurality ratio. It is remarkable to mention that this "urban-rural categorization" has only been found for the years 2016 and 2021. Alternately, the panel format contained the years 2012, 2015, and 2018 for the other variables and their corresponding GDP per capita. Thus, for this spreadsheet, the GDP per capita had to be adapted to 2016 and 2021. In Figure 11 the matching GDP per capita values can be found for the 2016 data.

$$GDPpc_{i,t} = \alpha + \beta_1 \cdot RuralRatioPct_{it} + \alpha_i + \varepsilon_{i,t} \quad (5)$$

α represents the intercept i.e., the baseline GDP per capita when rural ratio is zero. β_1 shows the effect of rural population share, α_i is for region-specific fixed effects and finally $\varepsilon_{i,t}$ displays the error term both accounting for time- and region-varying shocks.

Variable	Coef.	Std. Err.	t	P >| t |	95% Conf. Interval
RuralRatioPct	-58.67	7.4	-7.93	0.00	[-73.35; -43.99]
Cons	33,493.39	622.34	53.82	0.00	[32,256.06; 34,728.72]

Table 7: "Urban-Rural Ratio" regression results

The results are represented above, and they both seem to be significant as the p-values are both 0. The first variable tells that a 1 percentage increase in the rural population share causes a decrease of approximately 58.67 PPS in GDP per capita, while holding other factors constant. "Cons" represents the intercept when RuralRatioPct is equal to 0. It shows the average GDP per capita ≈ 33,500 PPS within a region when the independent variable (e.g., RuralRatioPct) is equal to 0, meaning the region is totally urban. Every 1% increase in rurality decreases this value by the abovementioned value of ≈ 59 PPS.

Impact of higher education on GDP per capita

Overall regression

The impact of higher education on GDP per capita is measured through a regression where the main independent variable represents the effect of land used in low education and the marginal impact of high education is computed thanks to this equation.

$$GDPpc_{i,t} = \alpha + \beta_1 \cdot LandUsed_{i,t} + \beta_2 \cdot (HighEdu_{it} \times LandUsed_{i,t}) + \varepsilon_{i,t} \quad (6)$$

Variable	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]
Land Used by NUTS 2 regions (β_1)	425.34	100.956	4.21	0.000	[226.62, 624.06]
Interaction: HighEdu × LandUsed (β_2)	-284.15	82.1095	-3.46	0.001	[-445.77, -122.53]

Table 8: Higher education regression results

The results come out significant for both variables as the p-values are ≈ 0. When there is no higher education, the effect of land used is equal to 425 PPS whereas when there is higher education, there is a huge gap. Thus, the effect of land used for higher education regions is calculated as follows:

$$425.34 + (-284.15) = 141.19 \text{ PPS} \quad (7)$$

Consequently, it can be deduced that for regions with a tertiary-education, the impact of higher-education is minor compared to regions that lack it, but still positive.

Regression across the regions in the European Union

To better investigate the GDP per capita impact of education, not only the NUTS 2 partition is done but also a more detailed picture can be viewed thanks to the subdivision of Europe into 5 main categories previously. To this end, the regression has been computed:

$$GDPpc_{i,t}=\alpha+\beta_1\cdot EducationLevel58_i+\sum_r \delta_r\cdot(RegionGroup_r\times EducationLevel58_{i,t})+\varepsilon_{i,t} \quad (8)$$

As it can be realized, this time there is a new symbol “sigma” used for accounting for the fact that each region’s own contribution can be summed but also can be demonstrated in an expanded format, as follows:

$$GDPpc_{i,t}=\alpha + \beta_1\cdot EducationLevel58_i +\delta_1\cdot(East \times Edu58) + \delta_2\cdot(North \times Edu58) + \delta_3\cdot(South \times Edu58) + \delta_4\cdot(West \times Edu58) + \varepsilon_{i,t} \quad (9)$$

Variable	Coefficient	Std. Err.	T	P>|t|	[95% Conf. Interval]
EducationLevels58 (Central)	408.50	58.85	6.94	0.0	[292.83, 524.17]
RegionGroup_East × EducationLevels58	582.15	181.32	3.21	0.001	[225.78, 938.53]
RegionGroup_North × EducationLevels58	142.33	139.91	1.02	0.31	[-132.64, 417.29]
RegionGroup_South × EducationLevels58	241.32	113.04	2.13	0.033	[19.16, 463.48]
RegionGroup_West × EducationLevels58	504.41	109.72	4.6	0.0	[288.75, 720.05]

Table 9: Marginal impact of higher education across European Union - regression results

Table 9 displays the fact that the marginal effect of tertiary education across European Union is substantial. To start off, the first row refers to the base group which has been chosen as the Central Europe, arbitrarily. For this region, 1% increase in higher education is associated with an increase of 408.5 PPS in per capita GDP, also the result is highly significant, underlined by the probability of rejecting the null hypothesis being equal to 0. Only for the North region the result is not significant as the p-value exceeds the limit of 5%, with a grand percentage of 31%. The calculation of the rest of the regions are dependent on the base group so it would be better to show them on a table:

Region	Base Effect – Central (β_1)	Interaction Effect (δ)	Marginal Effect ($\beta_1 + \delta$)
East	408.4985	582.1516	990.6501
North	408.4985	142.3250	550.8235
South	408.4985	241.3193	649.8178
West	408.4985	504.4069	912.9054

Table 10: Calculation of marginal effects by region

Table 10 summarises the marginal effects of higher education (levels 5–8) on GDP per capita across different European regions. The base effect, calculated for the Central region, remains constant across all comparisons, while the interaction terms represent the additional regional influence. As shown, the East displays the highest marginal effect, followed by the West, South, and North, although the marginal impact in the North is insignificant. These disparities suggest that the economic return on higher education is not uniform and may be shaped by region-specific factors such as labour market dynamics or local infrastructure. To better visualise these differences and facilitate comparison, the following figure presents the same data in a graphical format.

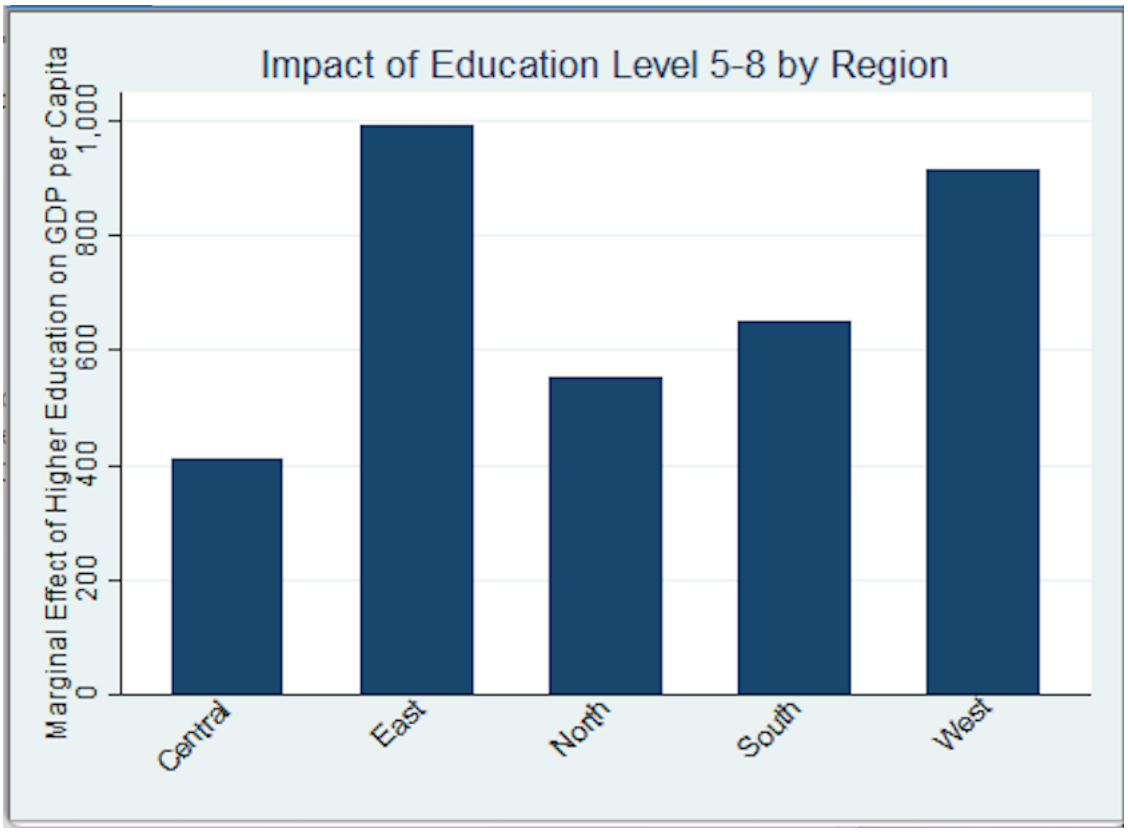

Figure 12: Marginal impact of education level 5-8 by region

As exhibited visually in Figure 12, the East region demonstrates a particularly stronger marginal effect of higher education on GDP per capita compared to other regions, followed by the West and South. These effects are observed for the years 2012, 2015, and 2018 so it is not a generally accepted fact but a more constrained one. This reinforces the numerical findings in Table 10 and highlights the regional gaps in the economic benefits of education. The relatively lower marginal effects observed in the North and Central regions may suggest that these areas are either closer to saturation in terms of educational returns or influenced by other economic factors. This visual evidence supports the argument that education policies may need to be regionally targeted to maximise their economic impact. To do so, instead of an approach that tries to fit to all the regions, those areas with higher marginal returns from education, like the Eastern and Western Europe, could prioritize the access to universities,

scientific research, vocational trainings. Instead, those that have a minor marginal return which are close to saturation could focus more on fostering innovation.

Bridging Empirical Results with Real-World Data

The data analysis conducted through the results obtained from the insertion of the regression equations to the Stata software have been finalized and it would be necessary to connect these findings with real-world evidence. Before getting to that, the marginal effects underlined the fact that, regarding higher education, land used enhancements would have the highest positive impact in the Eastern Europe, followed by the Western, Southern, Northern, and Central European regions. These results stem from the data taken from Eurostat.

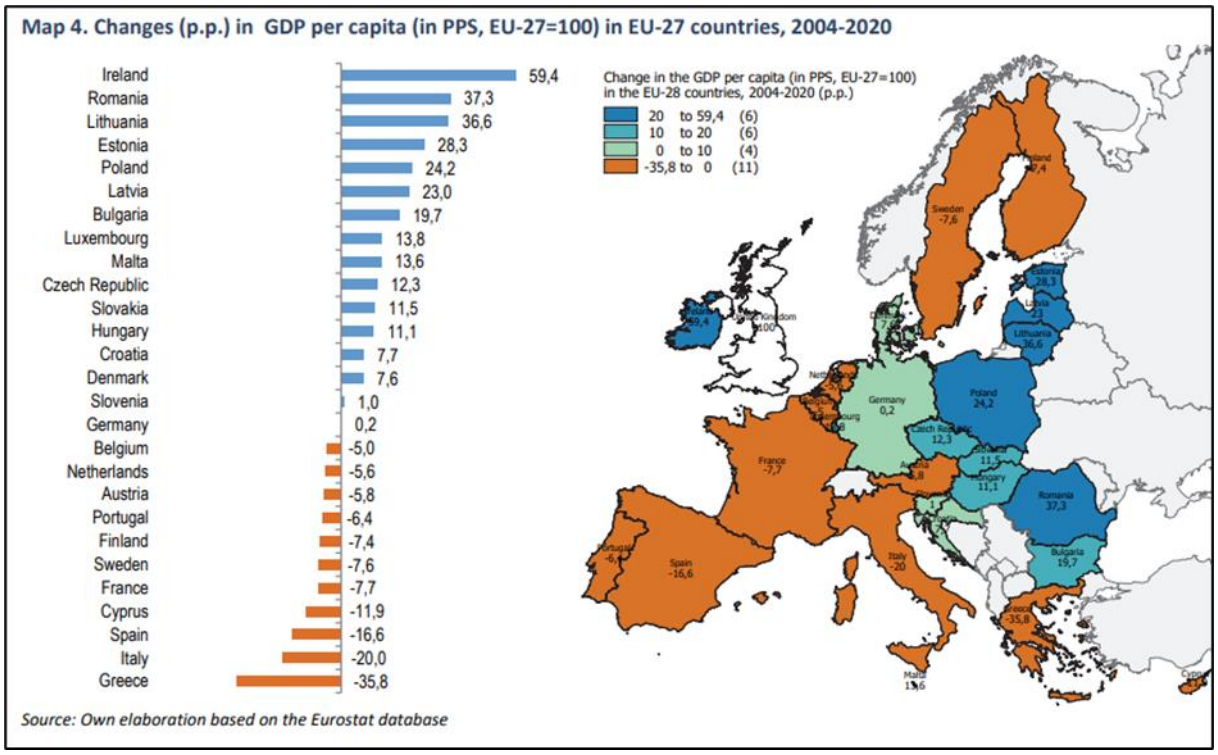

Figure 13: Changes in GDP per capita in the EU countries [20]

This figure shows the changes in GDP per capita (in PPS) at country-level between the period of 2004-2020. It is interesting to point out that the last four countries are part of the Southern Europe. Moreover, some of the Nordic countries show an uprising trend as Lithuania, Estonia, Latvia are shaded in turquoise with an increase above 20 percentage points (p.p.). Romania and Bulgaria exhibit a surge of 20 p.p. and more, which corresponds with the regression results obtained in higher education as the Eastern countries are

expected to have the highest marginal increase in GDP per capita through the interaction of education and land used. Poland displays an increase after its inclusion in the European Union in 2004, the country which plays an important role in the Central Europe as the Central region's higher education regression would trigger an increase of 408 PPS of GDP per capita.

These patterns align with the regression results obtained. Countries and regions with strong urban centres and concentrated investment in higher education tend to move up in the rankings. As already mentioned, Luxembourg and Ireland, although having small populations, stand out with extremely high GDP per capita as these values are inflated due to the cross-border workers and multinational flows, which may not return directly as population's income.

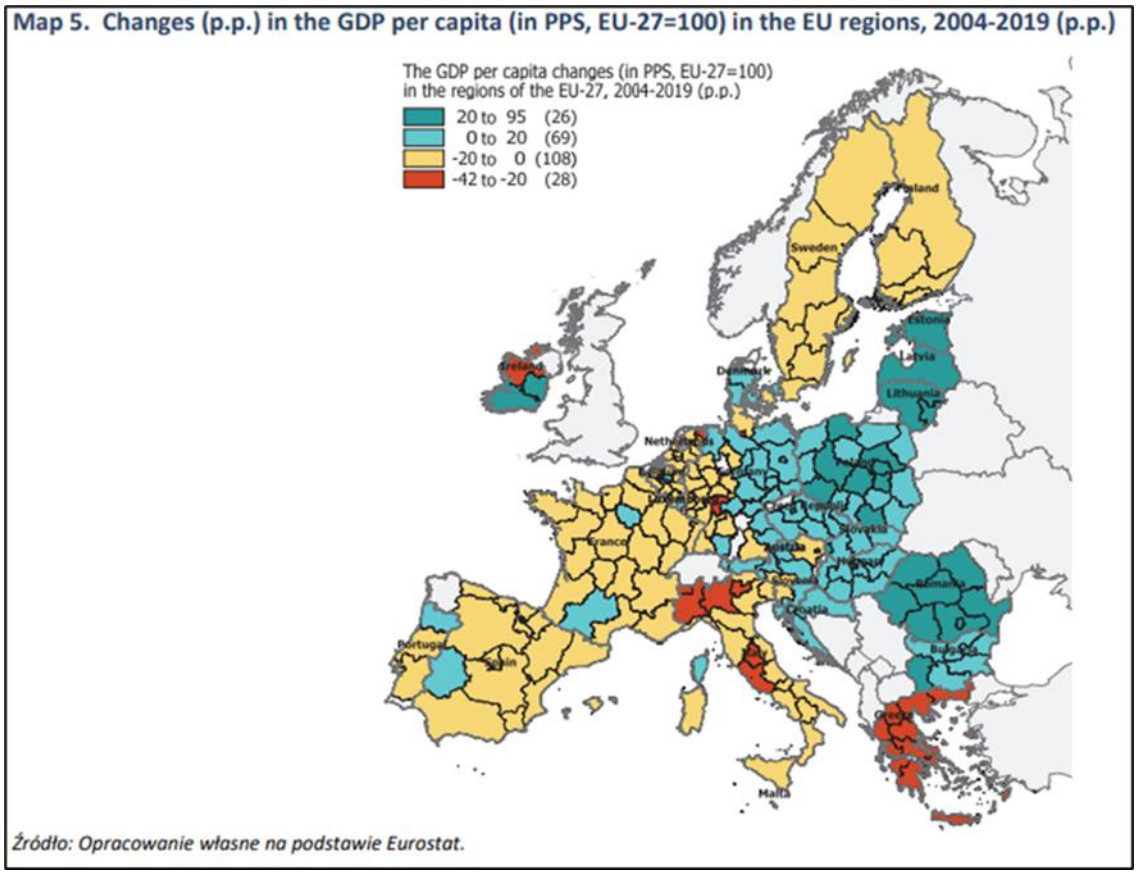

Figure 14: Changes in GDP per capita in the EU regions [20]

This figure shows which regions inside the European Union countries have increased or decreased their GDP per capita values, benchmarking the EU

average. An interesting fact is the strong surge of the Eastern European regions: While the regions of Hungary, Croatia, Bulgaria and Slovenia have been subject to an increase up to 20 percentage points, for Romanian regions this rise even soared up between 20-95 percentage points. The Northern region countries also present a likewise trend that of the Eastern countries. Estonia, Latvia, Lithuania, Denmark showcased positive changes whereas Finland and Sweden's GDP per capita values dropped. Contrarily, the Southern European regions, particularly some parts of Italy, Spain, and Greece were exposed to decline as showcased by most of the red and orange colouring. As the Southern part is eager to grow with a potential of 1696 PPS marginal increase in GDP per capita, this means that the capability of these regions is not utilized at its maximum. It would be good to focus on urban development and labour market accessibility to vitalize the economic activity. For sure tourism is one of the key factors in this region but it must be accompanied with other sectors to keep up with the GDP growth. Another interesting point to touch upon is Western and Central Europe that don't show a huge change. Some of the regions in France, Ireland, and Germany portrayed gains, but the rest of the regions were either stagnant or declining. It could be deduced that either there are not sufficient investments in these regions or there is saturation in terms of the effect of higher education and urbanization. Therefore, linking with the statistical findings, the areas with better infrastructure and education programs have realized more substantial benefits if their growth is not yet saturated.

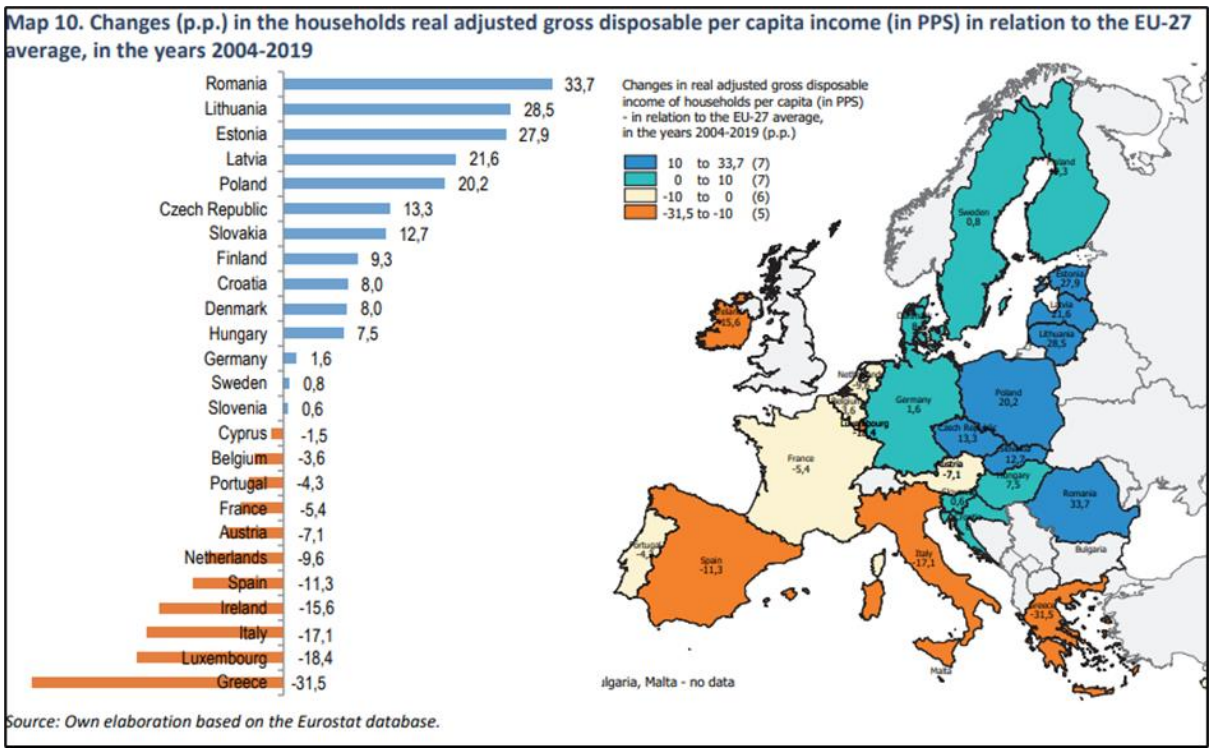

Figure 15: Changes in households' per capita income in the EU regions [20]

As a symbol of quality of life, this figure represents the changes in the households' real adjusted per capita income, the adjustment is for the price level differences. An important counterintuitive fact is the drop observed for Ireland and Luxembourg. As it was already touched upon, GDP growth may not always benefit the residents of the country itself and in this case the situation worsened. Although the two countries have high economic performance and which is expected to reflect to their living standards, the population might be suffering from the cost of living as the PPS adjustment mirrored the fact that the disposable income has decreased massively, by 15.6 and 18.4 percentage points. Another, even more important, fact is that all the countries in the Southern Europe have shown a declining trend in the disposable income. After the 2008 financial crisis the Southern Europe faced a recession phase where the unemployment increased. Moreover, during this 15-year-period there has been a decline in wages which caused the emigration of young people especially from Italy and Spain. For the Eastern and Central Europe, the situation had a positive sign which contributed to decrease the unemployment rates and thus the GDP per capita increased which

translated into higher household incomes. The positivity in the Northern European countries can be explained by the strong welfare systems that provide income support to its citizens even during economically problematic times, meaning that the social government understanding is very much observed. Moreover, there is a movement of digital infrastructure that is essential nowadays which also creates job opportunities for those who are eligible and seeking. The other region that fills the orange-part ranking is the Western Europe along with Southern Europe. In the Western European countries, the populations are aging which leads to economic downturn. As these countries have been living in prosperity generally, there is not as much search for increase in wages as in the Eastern. Moreover, the high taxing prevents the people having an easy access to high income.

As the Southern Europe has the highest marginal increase in GDP per capita, it is open to investments. For the East, the relatively low marginal increase is understandable as their potential is already revealed in this table with a positive change.

Conclusion

This thesis has been a research that scrutinized the relationship between infrastructure investment and regional economic performance with a focus on the European Union countries, utilizing GDP per capita as a proxy for income. Some control variables have also been used to demonstrate the situation for urban-rural, for the five regions in Europe as the North, South, East, West, and Central; and finally, to show the impact of higher education in these regions. To do so, a panel data structure has been chosen as not only to have different variables but also to be able to compare these variables over time among themselves. Thanks to the panel structure, the research has become more rigorous in terms of an economic regression model.

The initial regression model included all the variables chosen. Along with the main independent (Land Used by NUTS 2 Regions) and dependent variables (GDP per capita by NUTS 2 regions), 6 control variables have been tested. Although only higher education resulted significant, also population density has been chosen with a modification in the method of experimentation. Primary education, net migration, total population change, natural population change, population on January 1, have been discarded either they resulted insignificant or couldn't create any connection with the research after the regression.

Having analysed the rural and urban, it has been concluded that rurality has a negative influence on the economic output of the region. This doesn't necessarily mean that rural regions would always lag the urban, in fact they have a bigger potential of growth when compared with the urban, as already demonstrated by the marginal effect with the first model. It has been mentioned that the first model was not rigorous enough as it didn't meet the NUTS 3 definition. This is a limitation of the study which was then followed by a second model to demonstrate the negative impact of rurality on the economic output.

The results obtained for higher education attainment (levels 5-8) showed a statistically significant relationship with GDP per capita. The East would benefit the most from the marginal increase in GDP per capita whereas the Central would yield the least. The West and the and the South also show considerable increases, though in a lessor margin compared to the East. The North benefits a little above the Central, tough at a modest extent compared to other three regions.

The five regions' GDP per capita in terms of PPS has been examined. Also, the marginal increase that would be obtained by increasing the land used by 1% along with the final situation that has also been put after the addition of the marginal increase. It can be deduced stemming from the results of this thesis that the disparities in GDP per capita are not just results of structural factors such as geography or demographics. Instead, policy choices, historical development, strategic use and allocation of resources are crucial in explaining the discrepancies across the regions of the European Union.

One of the purposes of this thesis was to underline the differentiated regional policy strategies. To help mitigate the income disparities across the European Union some actions could be taken such as improving and incentivising people for higher education especially in the lower-performing areas. Improving the infrastructure such as transportation, telecommunication, and protective works. Transportation would ease the people's lives by facilitating the access to the universities. In the aspect of rural-urban, people who work in the urban areas could return their homes in an easier way for example by reducing the transportation times or increasing the frequency of the commute between rural and urban areas. As for telecommunication it is essential for education because the modern world requires the use of internet for education, as it was experienced by generation Z during the Covid-19 pandemic, without any access to Internet the higher education would have been interrupted, and the students couldn't have taken their exams.

There have been several limitations of this study. Although there are some valuable findings between infrastructure, education, urban-rural comparison, and income levels across European regions, the limitation part needs to be acknowledged. Initially, the study doesn't take into account the specific impacts of each sector that has been included in the "Land Used" parameter. Thus, transport, telecommunication, and energy sectors' impacts on GDP could be undermined or possibly overlooked. Secondly, the existence of 2008 financial crisis and/or the COVID-19 pandemic and their possible impacts on the gross domestic product of each country could have been addressed and thus analysed regionally although this would further complicate the research. As the third constraint, possibly, defining a region as urban or rural in a binary mode could have oversimplified the urban-rural case, although this classification has been done using the dataset of Eurostat.

For the future research, there are several options to be included to enrich the research more profoundly. The first one is to include longer time series, instead of just 3 years for two variables and 2 years for the third. A longer time series would provide a more robust panel data for instance having 10 years data for each variable. This was one of the shortcomings of this study as the data available have been used at its maximum availability. The second suggestion to improve this research is adding more variables that consider also other aspects such as healthcare access and digital infrastructure that would impact the GDP per capita. Another recommendation to enhance is maybe adding the countries outside the EU to see if there are similar issues and ongoing trends regarding rurality, education, and income outside the EU. This could show how other countries outside the EU address these topics and maybe could propose solutions that have been already working or could reject possible solutions that have been already attempted. Another action that could be taken is adjusting the part of the possible solution that didn't work out to implement in the EU, by taking lessons from previous failures of others to save both time and money.

What makes this thesis a significant one is the fact that it tries to unveil the relationship between infrastructure development, higher education attainment, rurality, and GDP per capita across different regions of the European Union. Utilizing statistics by means of regression models through the Stata software to obtain the coefficients of each variable, this research quantified how much do land used, rurality, and higher education change GDP per capita across North, South, East, West, and Central Europe.

Considering these findings, this thesis underlines the importance of creating integrated development strategies that address not only infrastructure but also human capital and institutional strength. The differences seen across European regions tell that a one-size-fits all policy doesn't seem likely to yield optimal results. So, tailoring regional strategies based on specific socio-economic and structural conditions seems essential.

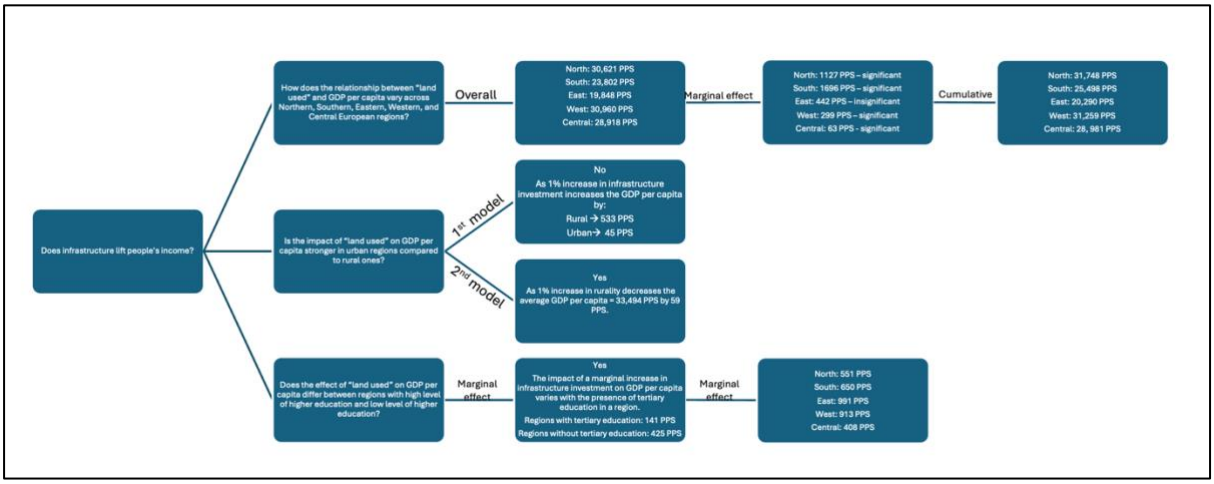

Figure 16: Answers to the research questions

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Appendix

Country	Average GDP per capita of 2012-2015-2018 (PPS)	Region
Luxembourg	75,933	West
Ireland	43,167	West
Croatia	36,983	East
Austria	35,326	Central
Germany	33,285	Central
Netherlands	33,153	West
Denmark	32,847	North
Sweden	32,825	North
Belgium	31,921	West
Finland	31,773	North
Malta	27,600	South
Italy	27,395	South
France	25,774	West
Slovakia	25,558	Central
Spain	25,448	South
Czechia	25,004	Central
Cyprus	24,800	South
Lithuania	24,233	North
Slovenia	23,600	East
Hungary	22,530	East
Portugal	22,005	South
Estonia	21,967	North
Latvia	17,533	North
Romania	17,217	East
Poland	17,098	Central
Greece	16,718	South
Bulgaria	12,372	East

NUTS 0	NUTS 2	NUTS_ID	URBAN RURAL CATEGORY	Rural Regions	Total Regions	Ratio of Rural/Total	GDP per capita 2016
1. Austria	Östösterreich	AT111	3	3	3	100%	#N/A
		AT112	3				
		AT113	3				
	Niederösterreich	AT121	3	4	7	57%	30200
		AT122	2				
		AT123	3				
		AT124	3				
		AT125	3				
		AT126	1				
		AT127	2				
	Wien	AT130	1	0	1	0%	43600
	Karnten	AT211	2	2	3	67%	#N/A
		AT212	3				
		AT213	3				
	Steirmark	AT221	2	4	6	67%	#N/A
		AT222	3				
		AT223	2				
		AT224	3				
		AT225	3				
		AT226	3				
	Oberösterreich	AT311	3	4	5	80%	37400
		AT312	2				
		AT313	3				
		AT314	3				
		AT315	3				
	Salzburg	AT321	3	2	3	67%	42600
		AT322	3				
		AT323	2				
	Tirol	AT331	3	4	5	80%	37900
		AT332	1				
		AT333	3				
		AT334	3				
		AT335	3				
	Vorarlberg	AT341	3	1	2	50%	39200
		AT342	1				

NUTS 0	NUTS 2	NUTS_ID	URBAN RURAL CATEGORY	Rural Regions	Total Regions	Ratio of Rural/Total	GDP per capita 2016
2. Belgium	Région de Bruxelles-Capitale/ Brussels Hoofdstedelijk Gewest	BE100	1	0	1	0%	#N/A
	Prov. Antwerpen	BE211	1	0	3	0%	39900
		BE212	1				
		BE213	2				
	Prov. Limburg (BE)	BE221	1	0	3	0%	27400
		BE222	2				
		BE223	2				
	Prov. Oost-Vlaanderen	BE231	1	0	6	0%	31000
		BE232	1				
		BE233	2				
		BE234	2				
		BE235	2				
		BE236	1				
	Prov. Vlaams-Brabant	BE241	1	0	2	0%	36800
		BE242	2				
	Prov. West-Vlaanderen	BE251	2	0	8	0%	32800
		BE252	2				
		BE253	2				
		BE254	1				
		BE255	2				
		BE256	2				
		BE257	2				
		BE258	2				
	Prov. Brabant wallon	BE310	2	0	1	0%	38700
	Prov. Hainut	BE321	3	2	7	29%	#N/A
		BE322	1				
		BE323	1				
		BE324	1				
		BE325	2				
		BE326	2				
		BE327	3				
	Prov. Liege	BE331	3	3	5	60%	#N/A
		BE332	1				
		BE334	3				
		BE335	2				
		BE336	3				
	Prov. Luxembourg (BE)	BE341	3	5	5	100%	20700
		BE342	3				
		BE343	3				
		BE344	3				
		BE345	3				
	Prov. Namur	BE351	3	2	3	67%	23000
		BE352	2				
		BE353	3				

NUTS 0	NUTS 2	NUTS_ID	URBAN RURAL CATEGORY	Rural Regions	Total Regions	Ratio of Rural/Total	GDP per capita 2016
3. Bulgaria	Severozapaden	BG311	3	1	5	20%	8600
		BG312	2				
		BG313	2				
		BG314	2				
		BG315	2				
	Severen tsentralen	BG321	2	2	5	40%	10000
		BG322	2				
		BG323	2				
		BG324	3				
		BG325	3				
	Severoiztochen	BG331	2	1	4	25%	11900
		BG332	2				
		BG333	2				
		BG334	3				
	Yugoiztochen	BG341	2	0	4	0%	12800
		BG342	2				
		BG343	2				
		BG344	2				
	Yugozapaden	BG411	1	1	5	20%	23000
		BG412	3				
		BG413	2				
		BG414	2				
		BG415	2				
	Yuzhen tsentralen	BG421	2	2	5	40%	10100
		BG422	2				
		BG423	2				
		BG424	3				
		BG425	3				
4. Cyprus	Kýpros	CY000	2	0	1	0%	24900
5. Czechia	Praha	CZ010	1	0	1	0%	56100
	Střední Čechy	CZ020	1	0	1	0%	23800
	Jihozápad	CZ031	3	2	2	100%	21700
		CZ032	3				
	Severozápad	CZ041	2	0	2	0%	17700
		CZ042	2				
	Severovýchod	CZ051	2	1	3	33%	20700
		CZ052	2				
		CZ053	3				
	Severovýchod	CZ063	3	1	2	50%	20700
		CZ064	2				
	Střední Morava	CZ071	2	0	2	0%	20400
		CZ072	2				
	Moravskoslezsko	CZ080	2	0	1	0%	20700

NUTS 0	NUTS 2	NUTS_ID	URBAN RURAL CATEGORY	Rural Regions	Total Regions	Ratio of Rural/Total	GDP per capita 2016
	Stuttgart	DE111	1	3	13	23%	45600
		DE112	1				
		DE113	1				
		DE114	1				
		DE115	1				
		DE116	1				
		DE117	2				
		DE118	2				
		DE119	3				
		DE11A	3				
		DE11B	3				
		DE11C	2				
		DE11D	2				
	Karlsruhe	DE121	1	3	12	25%	38700
		DE122	1				
		DE123	1				
		DE124	1				
		DE125	1				
		DE126	1				
		DE127	3				
		DE128	1				
		DE129	2				
		DE12A	3				
		DE12B	2				
		DE12C	3				
	Freiburg	DE131	2	1	10	10%	33600
		DE132	2				
		DE133	2				
		DE134	2				
		DE135	3				
		DE136	2				
		DE137	2				
		DE138	2				
		DE139	2				
		DE13A	2				
	Tübingen	DE141	2	2	9	22%	38200
		DE142	2				
		DE143	2				
		DE144	2				
		DE145	2				
		DE146	3				
		DE147	2				
		DE148	2				
		DE149	3				

NUTS 0	NUTS 2	NUTS_ID	URBAN RURAL CATEGORY	Rural Regions	Total Regions	Ratio of Rural/Total	GDP per capita 2016
	Oberbayern	DE211	2	5	23	22%	51200
		DE212	1				
		DE213	2				
		DE214	2				
		DE215	2				
		DE216	2				
		DE217	2				
		DE218	2				
		DE219	2				
		DE21A	3				
		DE21B	2				
		DE21C	2				
		DE21D	2				
		DE21E	3				
		DE21F	2				
		DE21G	3				
		DE21H	1				
		DE21I	3				
		DE21J	2				
		DE21K	2				
		DE21L	2				
		DE21M	3				
		DE21N	2				
	Niederbayern	DE221	3	12	12	100%	34600
		DE222	3				
		DE223	3				
		DE224	3				
		DE225	3				
		DE226	3				
		DE227	3				
		DE228	3				
		DE229	3				
		DE22A	3				
		DE22B	3				
		DE22C	3				
	Oberpfalz	DE231	2	6	10	60%	36700
		DE232	2				
		DE233	3				
		DE234	2				
		DE235	3				
		DE236	3				
		DE237	3				
		DE238	2				
		DE239	3				

NUTS 0	NUTS 2	NUTS_ID	URBAN RURAL CATEGORY	Rural Regions	Total Regions	Ratio of Rural/Total	GDP per capita 2016
		DE23A	3				
	Oberfranken	DE241	2	4	13	31%	33200
		DE242	2				
		DE243	2				
		DE244	2				
		DE245	2				
		DE246	2				
		DE247	2				
		DE248	2				
		DE249	2				
		DE24A	3				
		DE24B	3				
		DE24C	3				
		DE24D	3				
	Mittelfranken	DE251	3	4	12	33%	39100
		DE252	1				
		DE253	1				
		DE254	1				
		DE255	1				
		DE256	3				
		DE257	1				
		DE258	1				
		DE259	2				
		DE25A	3				
		DE25B	2				
		DE25C	3				
	Unterfranken	DE261	1	5	12	42%	35700
		DE262	2				
		DE263	2				
		DE264	1				
		DE265	3				
		DE266	3				
		DE267	3				
		DE268	3				
		DE269	2				
		DE26A	3				
		DE26B	2				
		DE26C	2				
		DE271	1				
		DE272	2				
		DE273	2				
		DE274	3				
		DE275	2				

NUTS 0	NUTS 2	NUTS_ID	URBAN RURAL CATEGORY	Rural Regions	Total Regions	Ratio of Rural/Total	GDP per capita 2016
	Schwaben	DE276	1	5	14	36%	35000
		DE277	3				
		DE278	3				
		DE279	2				
		DE27A	2				
		DE27B	2				
		DE27C	3				
		DE27D	3				
		DE27E	2				
	Berlin	DE300	1	0	1	0%	34700
	Brandenburg	DE401	2	4	18	22%	25000
		DE402	2				
		DE403	2				
		DE404	2				
		DE405	2				
		DE406	2				
		DE407	3				
		DE408	2				
		DE409	2				
		DE40A	2				
		DE40B	2				
		DE40C	2				
		DE40D	3				
		DE40E	2				
		DE40F	3				
		DE40G	2				
		DE40H	2				
		DE40I	3				
	Bremen	DE501	1	0	2	0%	42900
		DE502	2				#N/A
	Hamburg	DE600	1	0	1	0%	56700
	Darmstadt	DE711	1	1	14	7%	45600
		DE712	1				
		DE713	1				
		DE714	1				
		DE715	1				
		DE716	1				
		DE717	1				
		DE718	1				
		DE719	2				
		DE71A	1				
		DE71B	3				
		DE71C	1				
		DE71D	2				

NUTS 0	NUTS 2	NUTS_ID	URBAN RURAL CATEGORY	Rural Regions	Total Regions	Ratio of Rural/Total	GDP per capita 2016
6. Germany		DE71E	2				
	Gießen	DE721	2	1	5	20%	29800
		DE722	2				
		DE723	2				
		DE724	2				
		DE725	3				
	Kassel	DE731	2	4	7	57%	32500
		DE732	2				
		DE733	3				
		DE734	2				
		DE735	3				
		DE736	3				
		DE737	3				
	Mecklenburg-Vorpommern	DE803	2	6	8	75%	23500
		DE804	3				
		DE80J	3				
		DE80K	2				
		DE80L	3				
		DE80M	3				
		DE80N	3				
		DE80O	3				
	Braunschweig	DE911	2	2	10	20%	42800
		DE912	2				
		DE913	2				
		DE914	2				
		DE916	2				
		DE917	3				
		DE918	3				
		DE91A	2				
		DE91B	2				
		DE91C	2				
	Hannover	DE922	2	2	7	29%	33800
		DE923	2				
		DE925	2				
		DE926	3				
		DE927	3				
		DE928	2				
		DE929	1				
	Lüneburg	DE931	2	3	11	27%	24200
		DE932	2				
		DE933	2				
		DE934	3				
		DE935	2				
		DE936	2				

NUTS 0	NUTS 2	NUTS_ID	URBAN RURAL CATEGORY	Rural Regions	Total Regions	Ratio of Rural/Total	GDP per capita 2016
		DE937	3				
		DE938	2				
		DE939	2				
		DE93A	3				
		DE93B	2				
		DE941	1				
		DE942	2				
		DE943	2				
		DE944	2				
		DE945	2				
		DE946	2				
		DE947	2				
		DE948	3				
	Weser-Ems	DE949	3	3	17	18%	30900
		DE94A	2				
		DE94B	2				
		DE94C	2				
		DE94D	2				
		DE94E	2				
		DE94F	2				
		DE94G	2				
		DE94H	3				
		DEA11	1				
		DEA12	1				
		DEA13	1				
		DEA14	1				
		DEA15	1				
		DEA16	1				
		DEA17	1				
	Düsseldorf	DEA18	1	0	15	0%	35900
		DEA19	1				
		DEA1A	1				
		DEA1B	2				
		DEA1C	1				
		DEA1D	1				
		DEA1E	1				
		DEA1F	1				
		DEA22	1				
		DEA23	1				
		DEA24	1				
		DEA26	2				
		DEA27	1				
	Köln	DEA28	2	0	11	0%	37100

NUTS 0	NUTS 2	NUTS_ID	URBAN RURAL CATEGORY	Rural Regions	Total Regions	Ratio of Rural/Total	GDP per capita 2016
		DEA29	2				
		DEA2A	2				
		DEA2B	1				
		DEA2C	1				
		DEA2D	1				
		DEA31	1				
		DEA32	1				
		DEA33	1				
	Münster	DEA34	2	0	8	0%	29000
		DEA35	1				
		DEA36	1				
		DEA37	2				
		DEA38	2				
		DEA41	1				
		DEA42	1				
		DEA43	1				
	Detmold	DEA44	3	1	7	14%	33200
		DEA45	2				
		DEA46	2				
		DEA47	2				
		DEA51	1				
		DEA52	1				
		DEA53	1				
		DEA54	1				
		DEA55	1				
		DEA56	1				
	Arnsberg	DEA57	2	0	12	0%	30200
		DEA58	1				
		DEA59	2				
		DEA5A	2				
		DEA5B	2				
		DEA5C	1				
		DEB11	2				
		DEB12	2				
		DEB13	3				
		DEB14	2				
		DEB15	3				
	Koblenz	DEB17	2	5	11	45%	28900
		DEB18	2				
		DEB1A	2				
		DEB1B	3				
		DEB1C	3				
		DEB1D	3				
		DEB21	2				

NUTS 0	NUTS 2	NUTS_ID	URBAN RURAL CATEGORY	Rural Regions	Total Regions	Ratio of Rural/Total	GDP per capita 2016
	Trier	DEB22	3	3	5	60%	27000
		DEB23	3				
		DEB24	3				
		DEB25	2				
	Rheinhessen-Pfalz	DEB31	1	5	20	25%	33600
		DEB32	2				
		DEB33	1				
		DEB34	1				
		DEB35	1				
		DEB36	2				
		DEB37	3				
		DEB38	1				
		DEB39	1				
		DEB3A	2				
		DEB3B	3				
		DEB3C	2				
		DEB3D	3				
		DEB3E	1				
		DEB3F	2				
		DEB3G	3				
		DEB3H	2				
		DEB3I	1				
		DEB3J	2				
		DEB3K	3				
	Saarland	DEC01	1	0	6	0%	31700
		DEC02	2				
		DEC03	2				
		DEC04	1				
		DEC05	1				
		DEC06	2				
	Dresden	DED21	1	1	5	20%	26900
		DED2C	3				
		DED2D	2				
		DED2E	2				
		DED2F	1				
	Chemnitz	DED41	2	0	5	0%	24700
		DED42	2				
		DED43	2				
		DED44	2				
		DED45	2				
	Leipzig	DED51	1	1	3	33%	28400
		DED52	1				
		DED53	3				
		DEE01	2				

NUTS 0	NUTS 2	NUTS_ID	URBAN RURAL CATEGORY	Rural Regions	Total Regions	Ratio of Rural/Total	GDP per capita 2016
	Sachsen-Anhalt	DEE02	2	6	14	43%	24300
		DEE03	2				
		DEE04	3				
		DEE05	2				
		DEE06	3				
		DEE07	2				
		DEE08	3				
		DEE09	2				
		DEE0A	3				
		DEE0B	2				
		DEE0C	2				
		DEE0D	3				
		DEE0E	3				
	Schleswig-Holstein	DEF01	2	2	15	13%	28100
		DEF02	1				
		DEF03	2				
		DEF04	2				
		DEF05	3				
		DEF06	2				
		DEF07	3				
		DEF08	2				
		DEF09	1				
		DEF0A	1				
		DEF0B	2				
		DEF0C	2				
		DEF0D	2				
		DEF0E	2				
		DEF0F	2				
	Thüringen	DEG01	2	10	23	43%	25200
		DEG02	2				
		DEG03	2				
		DEG04	2				
		DEG05	2				
		DEG06	3				
		DEG07	2				
		DEG09	3				
		DEG0A	3				
		DEG0B	2				
		DEG0C	3				
		DEG0D	2				
		DEG0E	3				
		DEG0F	3				
		DEG0G	2				
		DEG0H	3				

NUTS 0	NUTS 2	NUTS_ID	URBAN RURAL CATEGORY	Rural Regions	Total Regions	Ratio of Rural/Total	GDP per capita 2016
		DEG0I	2				
		DEG0J	2				
		DEG0K	3				
		DEG0L	2				
		DEG0M	2				
		DEG0N	3				
		DEG0P	3				
7. Denmark	Hovedstaden	DK011	1	1	4	25%	46500
		DK012	1				
		DK013	2				
		DK014	3				
	Sjælland	DK021	2	1	2	50%	24800
		DK022	3				
	Syddanmark	DK031	2	0	2	0%	32300
		DK032	2				
	Midtjylland	DK041	3	1	2	50%	33000
		DK042	2				
	Nordjylland	DK050	3	1	1	100%	30100
8. Estonia	Eesti	EE001	1	3	5	60%	22200
		EE004	3				
		EE006	3				
		EE007	2				
		EE008	3				
9.Finland	Länsi-Suomi	FI193	3	4	5	80%	27300
		FI194	3				
		FI195	3				
		FI196	3				
		FI197	2				
	Helsinki-Uusimaa	FI1B1	1	0	1	0%	40900
	Etelä-Suomi	FI1C1	2	0	5	0%	27300
		FI1C2	2				
		FI1C3	2				
		FI1C4	2				
		FI1C5	2				
	Pohjois- ja Itä-Suomi	FI1D1	3	7	7	100%	25400
		FI1D2	3				
		FI1D3	3				
		FI1D5	3				
		FI1D7	3				
		FI1D8	3				
		FI1D9	3				
	Åland	FI200	3	1	1	100%	36600
		EL301	1				
		EL302	1				

NUTS 0	NUTS 2	NUTS_ID	URBAN RURAL CATEGORY	Rural Regions	Total Regions	Ratio of Rural/Total	GDP per capita 2016
10. Greece	Attiki	EL303	1	0	7	0%	26000
		EL304	1				
		EL305	1				
		EL306	1				
		EL307	1				
	Voreio Aigaio	EL411	3	2	3	67%	14300
		EL412	3				
		EL413	2				
	Notio Aigaio	EL421	2	1	2	50%	20400
		EL422	3				
	Kriti	EL431	2	2	4	50%	16100
		EL432	3				
		EL433	3				
		EL434	2				
	Anatoliki Makedonia, Thraki	EL511	2	2	5	40%	13100
		EL512	2				
		EL513	3				
		EL514	2				
		EL515	3				
	Kentriki Makedonia	EL521	2	4	7	57%	15000
		EL522	1				
		EL523	3				
		EL524	3				
		EL525	2				
		EL526	3				
		EL527	3				
	Dytiki Makedonia	EL531	3	2	3	67%	18800
		EL532	2				
		EL533	3				
	Ipeiros	EL541	3	2	3	67%	13000
		EL542	3				
		EL543	2				
	Thessalia	EL611	3	1	3	33%	14400
		EL612	2				
		EL613	2				
	Ionia Nisia	EL621	3	4	4	100%	17500
		EL622	3				
		EL623	3				
		EL624	3				
	Dytiki Ellada	EL631	3	2	3	67%	#N/A
		EL632	2				
		EL633	3				
		EL641	3				

NUTS 0	NUTS 2	NUTS_ID	URBAN RURAL CATEGORY	Rural Regions	Total Regions	Ratio of Rural/Total	GDP per capita 2016
	Sterea Ellada	EL642	3	5	5	100%	#N/A
		EL643	3				
		EL644	3				
		EL645	3				
	Peloponnisos	EL651	3	2	3	67%	16400
		EL652	2				
		EL653	3				
11. Spain	Galicia	ES111	2	2	4	50%	23300
		ES112	3				
		ES113	3				
		ES114	2				
	Principado de Asturias	ES120	2	0	1	0%	22600
	Cantabria	ES130	2	0	1	0%	23900
	País Vasco	ES211	1	0	3	0%	33300
		ES212	1				
		ES213	1				
	Comunidad Foral de Navarra	ES220	2	0	1	0%	32000
	La Rioja	ES230	2	0	1	0%	27800
	Aragón	ES241	2	1	3	33%	28400
		ES242	3				
		ES243	1				
	Comunidad de Madrid	ES300	1	0	1	0%	36000
	Castilla y León	ES411	3	4	9	44%	24200
		ES412	2				
		ES413	2				
		ES414	2				
		ES415	2				
		ES416	3				
		ES417	3				
		ES418	2				
		ES419	3				
	Castilla-La Mancha	ES421	2	1	5	20%	20700
		ES422	2				
		ES423	3				
		ES424	2				
		ES425	2				
	Extremadura	ES431	2	0	2	0%	19000
		ES432	2				
	Cataluña	ES511	1	0	4	0%	31100
		ES512	2				
		ES513	2				
		ES514	2				
	Comunitat Valenciana	ES521	1	0	3	0%	#N/A
		ES522	2				

NUTS 0	NUTS 2	NUTS_ID	URBAN RURAL CATEGORY	Rural Regions	Total Regions	Ratio of Rural/Total	GDP per capita 2016
		ES523	1				
	Illes Balears	ES531	2	0	3	0%	29100
		ES532	1				
		ES533	2				
	Andalucía	ES611	2	0	8	0%	19300
		ES612	1				
		ES613	1				
		ES614	2				
		ES615	2				
		ES616	2				
		ES617	1				
		ES618	1				
	Región de Murcia	ES620	1	0	1	0%	22100
	Ciudad de Ceuta	ES630	1	0	1	0%	19600
	Ciudad de Melilla	ES640	2	0	1	0%	18300
	Canarias	ES703	3	2	7	29%	21000
		ES704	2				
		ES705	1				
		ES706	3				
		ES707	2				
		ES708	2				
		ES709	1				
	Île-de-France	FR101	1	0	8	0%	#N/A
		FR102	2				
		FR103	1				
		FR104	1				
		FR105	1				
		FR106	1				
		FR107	1				
		FR108	1				
	Centre-Val de Loire	FRB01	3	4	6	67%	#N/A
		FRB02	3				
		FRB03	3				
		FRB04	2				
		FRB05	3				
		FRB06	2				
	Bourgogne	FRC11	2	3	4	75%	24200
		FRC12	3				
		FRC13	3				
		FRC14	3				
	Franche-Comté	FRC21	2	2	4	50%	22700
		FRC22	3				
		FRC23	3				
		FRC24	2				

NUTS 0	NUTS 2	NUTS_ID	URBAN RURAL CATEGORY	Rural Regions	Total Regions	Ratio of Rural/Total	GDP per capita 2016
12. France	Basse-Normandie	FRD11	2	2	3	67%	23600
		FRD12	3				
		FRD13	3				
	Haute-Normandie	FRD21	3	1	2	50%	25700
		FRD22	2				
	Nord-Pas-de-Calais	FRE11	1	0	2	0%	#N/A
		FRE12	2				
	Picardie	FRE21	3	2	3	67%	22000
		FRE22	2				
		FRE23	3				
	Alsace	FRF11	2	0	2	0%	27600
		FRF12	2				
	Champagne-Ardenne	FRF21	3	2	4	50%	24600
		FRF22	2				
		FRF23	2				
		FRF24	3				
	Lorraine	FRF31	2	2	4	50%	22000
		FRF32	3				
		FRF33	2				
		FRF34	3				
	Pays-de-la-Loire	FRG01	1	3	5	60%	#N/A
		FRG02	2				
		FRG03	3				
		FRG04	3				
		FRG05	3				
	Bretagne	FRH01	3	3	4	75%	25100
		FRH02	3				
		FRH03	2				
		FRH04	3				
	Aquitaine	FRI11	3	3	5	60%	26300
		FRI12	1				
		FRI13	3				
		FRI14	3				
		FRI15	2				
	Limousin	FRI21	3	3	3	100%	22000
		FRI22	3				
		FRI23	3				
	Poitou-Charentes	FRI31	3	4	4	100%	23900
		FRI32	3				
		FRI33	3				
		FRI34	3				
	Languedoc-Roussillon	FRJ11	3	2	5	40%	22300
		FRJ12	2				
		FRJ13	2				

NUTS 0	NUTS 2	NUTS_ID	URBAN RURAL CATEGORY	Rural Regions	Total Regions	Ratio of Rural/Total	GDP per capita 2016
		FRJ14	3				
		FRJ15	2				
	Midi-Pyrénées	FRJ21	3	7	8	88%	27300
		FRJ22	3				
		FRJ23	1				
		FRJ24	3				
		FRJ25	3				
		FRJ26	3				
		FRJ27	3				
		FRJ28	3				
	Auvergne	FRK11	3	3	4	75%	23600
		FRK12	3				
		FRK13	3				
		FRK14	2				
	Rhône-Alpes	FRK21	3	3	8	38%	29800
		FRK22	3				
		FRK23	3				
		FRK24	2				
		FRK25	2				
		FRK26	1				
		FRK27	2				
		FRK28	2				
	Provence-Alpes-Côte d'Azur	FRL01	3	2	6	33%	27900
		FRL02	3				
		FRL03	1				
		FRL04	1				
		FRL05	2				
		FRL06	2				
	Corse	FRM01	3	2	2	100%	23400
		FRM02	3				
	Guadeloupe	FRY10	2	0	1	0%	19800
	Martinique	FRY20	2	0	1	0%	20600
	Guyane	FRY30	2	0	1	0%	13700
	La Réunion	FRY40	1	0	1	0%	19000
	Mayotte	FRY50	2	0	1	0%	8000
	Jadranska Hrvatska	HR031	2	3	8	38%	17300
		HR032	3				
		HR033	3				
		HR034	2				
		HR035	2				
		HR036	3				
		HR037	2				
		HR041	1				

NUTS 0	NUTS 2	NUTS_ID	URBAN RURAL CATEGORY	Rural Regions	Total Regions	Ratio of Rural/Total	GDP per capita 2016
13. Croatia	Kontinentalna Hrvatska	HR042	3	10	14	71%	#N/A
		HR043	3				
		HR044	2				
		HR045	3				
		HR046	3				
		HR047	3				
		HR048	3				
		HR049	3				
		HR04A	2				
		HR04B	2				
		HR04C	3				
		HR04D	3				
		HR04E	3				
14. Hungary	Budapest	HU110	1	0	1	0%	39700
	Pest	HU120	2	0	1	0%	15700
	Közép-Dunántúl	HU211	2	0	3	0%	18800
		HU212	2				
		HU213	2				
	Nyugat-Dunántúl	HU221	2	1	3	33%	21300
		HU222	2				
		HU223	3				
	Dél-Dunántúl	HU231	2	2	3	67%	13100
		HU232	3				
		HU233	3				
	Észak-Magyarország	HU311	2	2	3	67%	12900
		HU312	3				
		HU313	3				
	Észak-Alföld	HU321	2	1	3	33%	12300
		HU322	2				
		HU323	3				
	Dél-Alföld	HU331	2	0	3	0%	14100
		HU332	2				
		HU333	2				
15. Ireland	Northern and Western	IE041	3	2	2	100%	23300
		IE042	3				
	Southern	IE051	3	3	3	100%	55200
		IE052	3				
		IE053	3				
	Eastern and Midland	IE061	1	1	3	33%	58200
		IE062	2				
		IE063	3				
		ITC11	1				
		ITC12	2				
		ITC13	2				

NUTS 0	NUTS 2	NUTS_ID	URBAN RURAL CATEGORY	Rural Regions	Total Regions	Ratio of Rural/Total	GDP per capita 2016
	Piemonte	ITC14	2	3	8	38%	29500
		ITC15	2				
		ITC16	3				
		ITC17	3				
		ITC18	3				
	Valle d'Aosta/Vallée d'Aoste	ITC20	2	0	1	0%	36000
	Liguria	ITC31	1	0	4	0%	30700
		ITC32	2				
		ITC33	1				
		ITC34	1				
	Lombardia	ITC41	1	1	12	8%	37100
		ITC42	1				
		ITC43	1				
		ITC44	2				
		ITC46	1				
		ITC47	2				
		ITC48	2				
		ITC49	2				
		ITC4A	2				
		ITC4B	3				
		ITC4C	1				
		ITC4D	1				
	Abruzzo	ITF11	3	1	4	25%	24100
		ITF12	2				
		ITF13	2				
		ITF14	2				
	Molise	ITF21	3	2	2	100%	19800
		ITF22	3				
	Campania	ITF31	1	1	5	20%	18100
		ITF32	3				
		ITF33	1				
		ITF34	2				
		ITF35	2				
	Puglia	ITF43	1	1	6	17%	18100
		ITF44	1				
		ITF45	1				
		ITF46	3				
		ITF47	1				
		ITF48	1				
	Basilicata	ITF51	3	1	2	50%	21500
		ITF52	2				
		ITF61	2				
		ITF62	2				

NUTS 0	NUTS 2	NUTS_ID	URBAN RURAL CATEGORY	Rural Regions	Total Regions	Ratio of Rural/Total	GDP per capita 2016
16. Italy	Calabria	ITF63	2	1	5	20%	16700
		ITF64	3				
		ITF65	2				
	Sicilia	ITG11	2	0	9	0%	17200
		ITG12	1				
		ITG13	2				
		ITG14	2				
		ITG15	1				
		ITG16	2				
		ITG17	1				
		ITG18	2				
		ITG19	1				
	Sardegna	ITG25	2	3	8	38%	20300
		ITG26	3				
		ITG27	2				
		ITG28	3				
		ITG29	2				
		ITG2A	3				
		ITG2B	2				
		ITG2C	2				
	Provincia Autonoma di Bolzano/ Bozen	ITH10	3	1	1	100%	#N/A
	Provincia Autonoma di Trento	ITH20	2	0	1	0%	36100
	Veneto	ITH31	2	2	7	29%	31600
		ITH32	2				
		ITH33	3				
		ITH34	2				
		ITH35	1				
		ITH36	2				
		ITH37	3				
	Friuli-Venezia Giulia	ITH41	2	0	4	0%	29800
		ITH42	2				
		ITH43	1				
		ITH44	1				
	Emilia-Romagna	ITH51	2	0	9	0%	34200
		ITH52	2				
		ITH53	2				
		ITH54	2				
		ITH55	2				
		ITH56	2				
		ITH57	2				
		ITH58	2				
		ITH59	1				
		ITI11	2				
		ITI12	2				

NUTS 0	NUTS 2	NUTS_ID	URBAN RURAL CATEGORY	Rural Regions	Total Regions	Ratio of Rural/Total	GDP per capita 2016
	Toscana	ITI12	2	2	10	20%	29900
		ITI13	1				
		ITI14	1				
		ITI15	1				
		ITI16	2				
		ITI17	2				
		ITI18	2				
		ITI19	3				
		ITI1A	3				
	Umbria	ITI21	2	2	2	100%	24400
		ITI22	2				
	Marche	ITI31	2	0	5	0%	26200
		ITI32	2				
		ITI33	2				
		ITI34	2				
		ITI35	2				
	Lazio	ITI41	3	2	5	40%	33200
		ITI42	3				
		ITI43	1				
		ITI44	2				
		ITI45	2				
17. Lithuania	Sostinės regionas	LT011	1	0	1	0%	31400
	Vidurio ir vakarų Lietuvos regionas	LT021	2	2	9	22%	17500
		LT022	2				
		LT023	2				
		LT024	3				
		LT025	2				
		LT026	2				
		LT027	3				
		LT028	2				
		LT029	2				
18. Luxembourg	Luxembourg	LU000	2	0	1	0%	78500
19. Latvia	Latvija	LV003	2	2	7	29%	17900
		LV005	2				
		LV006	1				
		LV007	2				
		LV008	3				
		LV009	3				
20. Malta	Malta	MT001	1	0	2	0%	28400
		MT002	1				
	Groningen	NL111	2	0	3	0%	36600
		NL112	2				
		NL113	2				
		NL124	2				

NUTS 0	NUTS 2	NUTS_ID	URBAN RURAL CATEGORY	Rural Regions	Total Regions	Ratio of Rural/Total	GDP per capita 2016
21. Netherlands	Friesland (NL)	NL125	2	0	3	0%	26100
		NL126	2				
	Drenthe	NL131	2	0	3	0%	25600
		NL132	2				
		NL133	2				
	Overijssel	NL211	2	0	3	0%	31000
		NL212	2				
		NL213	1				
	Gelderland	NL221	1	0	4	0%	31000
		NL224	2				
		NL225	2				
		NL226	1				
	Flevoland	NL230	1	0	1	0%	27400
	Utrecht	NL310	1	0	1	0%	44000
	Noord-Holland	NL321	1	0	7	0%	48300
		NL323	1				
		NL324	1				
		NL325	1				
		NL327	1				
		NL328	1				
		NL329	1				
	Zuid-Holland	NL332	1	0	6	0%	36800
		NL333	1				
		NL337	1				
		NL33A	1				
		NL33B	1				
		NL33C	1				
	Zeeland	NL341	3	1	2	50%	29000
		NL342	2				
	Noord-Brabant	NL411	1	0	4	0%	37300
		NL412	1				
		NL413	2				
		NL414	1				
	Limburg (NL)	NL421	2	0	3	0%	32500
		NL422	2				
		NL423	1				
	Małopolskie	PL213	1	3	6	50%	17800
		PL214	2				
		PL217	3				
		PL218	3				
		PL219	3				
		PL21A	2				
		PL224	2				
		PL225	2				

A	B	C	D	E	F	G	H
NUTS 0	NUTS 2	NUTS_ID	URBAN RURAL CATEGORY	Rural Regions	Total Regions	Ratio of Rural/Total	GDP per capita 2016
22. Poland	Śląskie	PL225	2	0	8	0%	20400
		PL227	1				
		PL228	1				
		PL229	1				
		PL22A	1				
		PL22B	1				
		PL22C	1				
	Wielkopolskie	PL411	3	4	6	67%	21400
		PL414	3				
		PL415	1				
		PL416	3				
		PL417	3				
		PL418	2				
	Zachodniopomorskie	PL424	2	1	4	25%	16700
		PL426	2				
		PL427	3				
		PL428	2				
	Lubuskie	PL431	2	0	2	0%	16600
		PL432	2				
	Dolnośląskie	PL514	1	0	5	0%	21900
		PL515	2				
		PL516	2				
		PL517	2				
		PL518	2				
	Opolskie	PL523	3	1	2	50%	16300
		PL524	2				
	Kujawsko-pomorskie	PL613	1	4	5	80%	16100
		PL616	3				
		PL617	3				
		PL618	3				
		PL619	3				
	Warmińsko-mazurskie	PL621	2	0	3	0%	14200
		PL622	2				
		PL623	2				
	Pomorskie	PL633	1	1	5	20%	19100
		PL634	2				
		PL636	2				
		PL637	3				
		PL638	2				
	Łódzkie	PL711	1	3	5	60%	18300
		PL712	1				
		PL713	3				
		PL714	3				
		PL715	3				

NUTS 0	NUTS 2	NUTS_ID	URBAN RURAL CATEGORY	Rural Regions	Total Regions	Ratio of Rural/Total	GDP per capita 2016
	Świętokrzyskie	PL721	2	1	2	50%	14200
		PL722	3				
	Lubelskie	PL811	3	3	4	75%	13600
		PL812	3				
		PL814	2				
		PL815	3				
	Podkarpackie	PL821	3	4	4	100%	14000
		PL822	3				
		PL823	3				
		PL824	3				
	Podlaskie	PL841	2	2	3	67%	14300
		PL842	3				
		PL843	3				
	Warszawski stołeczny	PL911	1	0	3	100%	41900
		PL912	2				
		PL913	2				
	Mazowiecki regionalny	PL921	2	5	6	83%	17000
		PL922	3				
		PL923	3				
		PL924	3				
		PL925	3				
		PL926	3				
23. Portugal	Norte	PT111	3	4	8	50%	18600
		PT112	2				
		PT119	2				
		PT11A	1				
		PT11B	3				
		PT11C	2				
		PT11D	3				
		PT11E	3				
	Algarve	PT150	2	0	1	0%	23400
	Centro (PT)	PT16B	3	7	8	88%	:
		PT16D	2				
		PT16E	3				
		PT16F	3				
		PT16G	3				
		PT16H	3				
		PT16I	3				
		PT16J	3				
	Área Metropolitana de Lisboa	PT170	1	0	1	0%	#N/A
	Alentejo	PT181	3	5	5	100%	:
		PT184	3				
		PT185	3				
		PT186	3				

NUTS 0	NUTS 2	NUTS_ID	URBAN RURAL CATEGORY	Rural Regions	Total Regions	Ratio of Rural/Total	GDP per capita 2016
		PT187	3				
	Região Autónoma dos Açores	PT200	2	0	1	0%	19700
	Região Autónoma da Madeira	PT300	1	0	1	0%	21300
24. Romania	Nord-Vest	RO111	3	5	6	83%	14900
		RO112	3				
		RO113	2				
		RO114	3				
		RO115	3				
		RO116	3				
	Centru	RO121	3	4	6	67%	15800
		RO122	2				
		RO123	3				
		RO124	3				
		RO125	3				
		RO126	2				
	Nord-Est	RO211	3	5	6	83%	10200
		RO212	3				
		RO213	2				
		RO214	3				
		RO215	3				
		RO216	3				
	Sud-Est	RO221	2	3	6	50%	13900
		RO222	3				
		RO223	2				
		RO224	2				
		RO225	3				
		RO226	3				
	Sud-Muntenia	RO311	3	6	7	86%	13300
		RO312	3				
		RO313	3				
		RO314	3				
		RO315	3				
		RO316	2				
		RO317	3				
	București-Ilfov	RO321	1	0	2	0%	#N/A
		RO322	1				
	Sud-Vest Oltenia	RO411	2	4	5	80%	11900
		RO412	3				
		RO413	3				
		RO414	3				
		RO415	3				
	Vest	RO421	2	1	4	25%	17700
		RO422	3				
		RO423	2				

NUTS 0	NUTS 2	NUTS_ID	URBAN RURAL CATEGORY	Rural Regions	Total Regions	Ratio of Rural/Total	GDP per capita 2016
		RO424	2				
25. Sweden	Stockholm	SE110	1	0	1	0%	48600
	Östra Mellansverige	SE121	2	0	5	0%	30100
		SE122	2				
		SE123	2				
		SE124	2				
		SE125	2				
	Småland med öarna	SE211	2	3	4	75%	30200
		SE212	3				
		SE213	3				
		SE214	3				
	Sydsverige	SE221	2	0	2	0%	29500
		SE224	2				
	Västsverige	SE231	2	0	2	0%	34500
		SE232	1				
	Norra Mellansverige	SE311	2	1	3	33%	27800
		SE312	3				
		SE313	2				
	Mellersta Norrland	SE321	2	1	2	50%	29400
		SE322	3				
	Övre Norrland	SE331	2	0	2	0%	31700
		SE332	2				
26. Slovenia	Vzhodna Slovenija	SI031	3	8	8	100%	19100
		SI032	3				
		SI033	3				
		SI034	3				
		SI035	3				
		SI036	3				
		SI037	3				
		SI038	3				
	Zahodna Slovenija	SI041	2	1	4	25%	28100
		SI042	2				
		SI043	3				
		SI044	2				
27. Slovakia	Bratislavský kraj	SK010	1	0	1	0%	51600
	Západné Slovensko	SK021	3	1	3	33%	18800
		SK022	2				
		SK023	2				
	Stredné Slovensko	SK031	2	1	2	50%	16500
		SK032	3				
	Východné Slovensko	SK041	3	1	2	50%	14300
		SK042	2				