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Satisfaction with the Environmental Condition in the Italian Regions between 2004 and 2020

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Abstract

In the following article, the "*Satisfaction with the Environmental Condition*" in the 20 Italian regions between 2004 and 2020 was estimated using ISTAT-BES data. The data were analyzed using the following econometric techniques, namely: Panel Data with Random Effects, Panel Data with Fixed Effects, Dynamic Panel, Pooled OLS, WLS. The results show that satisfaction with the environmental situation is positively associated with the following variables "*People with at least high school diploma*", "*Satisfaction with leisure time*", "*Concern for the deterioration of the landscape*" and negatively associated with "*Gross disposable income per capita*", "*Dissatisfaction with the landscape of the place of life*", "*Perception of the risk of crime*". A cluster analysis was then carried out using the unsupervised k-Means algorithm optimized through the Silhouette coefficient and 3 clusters were found. A comparative analysis was then carried out between eight different machine learning algorithms to predict the trend of satisfaction by environmental situation. The analysis showed that the Tree Ensemble Regression algorithm is the best predictor and estimates a reduction of the variable of 0.05%. Subsequently, using augmented data, a further prediction was made with an estimated result equal to −1.93%.

Keywords

Environmental Economics, Valuation of Environmental Effects, Sustainability, Government Policy, Ecological Economics

1. Introduction and Research Question

In this article, the determinants of satisfaction with the environmental condition in the Italian regions between 2004 and 2020 are inquired about. The data used

refer to the ISTAT-BES database. Satisfaction with environmental conditions has become one of the increasingly important issues in the Western world, and in the Asian continent in the face of the macro phenomena of global warming. In fact, more and more often both in industrialized countries and in new developing countries and in developing countries there is increasing attention to the environmental issue, especially in terms of controlling CO_2 emissions. Citizens, especially in Europe, are increasingly concerned about the environmental situation and believe that living in places that are satisfactory from an environmental point of view is an essential component of individual well-being. Obviously, this condition has led not only to the introduction of global macro-policies such as those of the Paris Agreements and the Cop26 in Glasgow, but it has also guided the economic policies defined at the regional and metropolitan area levels. In fact, concern for the environmental condition is no longer understood as something distant that must be decided only at the international level but rather as a dimension of local economic policy that can be implemented near the citizens.

Therefore, this article analyzes the determinants of satisfaction for the environment considered not only from a green point of view but also from an economic-social point of view. Obviously, in the case of Italy, it was necessary to associate a cluster analysis with the classical econometric analysis. In fact, Italy is notoriously a country divided into two parts: an evolved Center-North and a less developed southern part. And therefore, using cluster analysis, an attempt was made to verify whether this distinction persisted even in the case of the analysis of the evaluation of satisfaction with the environmental condition. The cluster analysis is necessary to verify the presence of areas of convergence and areas of divergence, especially for countries such as Italy characterized by significant differences in the structure of regional economies. Through clusters, it is therefore possible to verify the presence of groupings between regions that reflect or not the general trend of the gap between central-northern and southern Italy.

Finally, we used machine learning techniques to predict the future value of satisfaction with the environmental condition. In fact, we wondered if using predictive techniques, both using historical data and using augmented data, it was possible for some way to predict the future value of Italians' satisfaction with the environmental condition. We first tried to identify the best predictive tool by comparing the performance of eight different algorithms and then we analyzed a comparison between the statistical errors made with the time series and the statistical errors made using increased data.

Finally, based on the analysis carried out, we tried to investigate the presence of possible economic policy suggestions that could be implemented to ensure that the level of satisfaction with the environmental condition increased in the Italian regions.

2. Literature Review

A brief analysis of the scientific literature is presented below, above all on an empirical and metric basis, which demonstrates how the theme of environmen-

tal satisfaction is very widespread, especially in analyzes that use the life satisfaction approach. The articles reported all present metric case studies that highlight the importance of the environmental condition as an essential component for the well-being of the population in both developed and developing countries.

Tsurumi & Managi [1] calculate the willingness to pay for the availability of green spaces for Japanese citizens of the Kanto and Kansai regions. The willingness to pay is inversely proportional to the distance from the green. The more citizens are distant from green areas, the more they are willing to pay for the availability of green areas. Using the life satisfaction method, Ambrey & Fleming [2] analyze the willingness to pay of Australian citizens to access good level naturalistic landscape spaces. The authors show that Australian citizens surveyed are willing to pay around 12,000 Australian dollars to access good environmental landscapes. Ambrey & Fleming [3] analyze the relationship between life satisfaction and the presence of public green in Australia. The authors show that, for the analyzed sample, citizens are willing to pay around $1168 per household for a 1% increase in public green space. The presence of green space improves the well-being of urban residents. de Oliveira, *et al.* [4] analyze the satisfaction with the environment of visitors to the Iguaçu National Park in Brazil. The authors show that environmentalists can be particularly sensitive to the fact that there are buildings in nature parks or also to the fact that there is an excess of visits that can in some way spoil the naturalistic experience of visiting the park. However, the 434 interviews show a high level of satisfaction of conservationists with the Brazilian natural park.

Frey, *et al.* [5] try to estimate the relationship between satisfaction with sight and satisfaction with the condition of the environment. The authors verify the existence of a negative relationship between the presence of pollution and life satisfaction. Citizens are willing to pay to have access to landscape and naturalistic assets capable of increasing satisfaction with the living conditions. Chen, *et al.* [6] refer to the relationship among air pollution, legality, and Chinese life satisfaction. The authors verify that where there is greater pollution, Chinese citizens have less propensity to comply with the law and have less satisfaction with life.

Senlier, *et al.* [7] highlight how environmental elements, such as air quality, have a significant impact in determining the quality of life in urban spaces. The authors test their hypotheses in the case of Kocaeli, a Turkish city with significant industrial activity. The analysis leads to the definition of participatory economic policies that can allow the population to live in a city with a higher quality of life. Wang, *et al.* [8] analyze the relationship between the quality and quantity of green space and its impact on mental health. The results show that increasing the quantity of green space has a positive impact on mental health and that increasing the quality of green space increases cognitive abilities. Rajani, *et al.* [9] analyze the case of the relationship between environmental condition and satisfaction with living conditions using logistic regression tools. The authors verify that there is a negative relationship between environmental degradation and life satisfaction. McCormack, *et al.* [10] analyze the relationship between the pres-

ence of urban parks and the physical activity of citizens. The development of green spaces can increase citizens' aptitude for physical activity with positive impacts also in terms of life satisfaction. Wu, *et al.* [11] investigate the impact that satisfaction with the environment and satisfaction with the climate have on the tourist experience. The results show that satisfaction with environmental and natural conditions has a positive impact on the physical and mental health of tourists and therefore on their satisfaction with the tourist services offered. Ambrey, *et al.* [12] analyze the relationship between air pollution and life satisfaction in Southeast Queensland in Australia. Through econometric analysis, the authors verify the existence of a negative relationship between the value of air pollution and life satisfaction. Analyze the relationship between air pollution and life satisfaction in Southeast Queensland in Australia. Through econometric analysis, the authors verify the existence of a negative relationship between the value of air pollution and life satisfaction. The authors also estimate the "*Willingness to Pay*" of Australian households and find that willingness to pay tends to increase with income. That is, households with higher incomes tend to be more sensitive to the environment and are willing to pay larger portions of their income to reduce air pollution.

Fleming, *et al.* [13] estimate the relationship between green spaces and the satisfaction with life of New Zealand citizens also considering the impact of fear of crime. The authors use a logit model to estimate the relationship between the presence of green patients and satisfaction with life of New Zealanders. The results show the existence of a positive relationship, that is: the growth of green spaces also increases life satisfaction. However, this relationship is canceled in case of fear of crime. In fact, citizens who show that they are significantly frightened by crime fail to have the advantages in terms of life statistics produced in connection with the presence of green spaces. Therefore, green spaces can produce positive effects on life satisfaction only if citizens are free from the fear of crime. Wang & Kang [14] consider the relationship between life satisfaction and environmental sensitivity in China. The authors believe that the increase in life satisfaction leads to a greater sensitivity for the environment condition. Thus, the research suggests that acting on the life satisfaction of the population could have positive impacts in terms of sensitivity towards environmental protection policies.

Ma, *et al.* [15] estimate the relationship between air pollution and commuter satisfaction with the quality of transportation in China. The authors verify that the increase in urban pollution0 reduces the quality of freight transport in China with significant effects in terms of reduction of life satisfaction. It follows that finding means of transport that are more environmentally friendly has a significant impact not only on the commuter experience but also on the overall life satisfaction of Chinese people. Omri, *et al.* [16] analyze the relationship between the quality of the environment and the quality of life in 36 emerging countries in the period between 2005 and 2014. The econometric analysis shows that environmental degradation is negatively associated with life satisfaction. However,

the presence of economic policies aimed at the creation of renewable energy plants has a very positive impact in increasing life satisfaction even for those countries characterized by environmental degradation. Zhang, *et al.* [17] consider the relationship between satisfaction with the environment, pollution, and the weather condition in the city of Lanzhou in China. The econometric analysis shows that citizens are more sensitive to environmental pollution rather than to the weather conditions in the perception of life satisfaction.

Ambrey & Fleming [18] analyze the relationship between the quality of the environment and life satisfaction in Australia. The metric analysis shows that in general the presence of parks and green areas, including urban ones, has a positive impact on the quality of life of Australian citizens. However, there are also some paradoxical effects. That is, while citizens living near the coast and rivers declare high levels of life satisfaction, citizens living near parks declare reduced life satisfaction. However, with the growing distance from natural parks, life satisfaction tends to increase. It follows that although parks are generally able to increase citizens' life satisfaction, even if living near parks has counterfactual effects on life satisfaction. MacKerron & Mourato [19] consider the relationship between access to naturalistic environments and subjective well-being in the UK. The authors verify that people who have access to green spaces, nature and a cleaner environment report higher levels of subjective well-being than people living in urban spaces. Biedenweg, *et al.* [20] verify the presence of a positive relationship between access to landscape and naturalistic resources and subjective well-being in the Puget Sound area of Washington State in the USA.

Furthermore, it is also necessary to consider that the quality of the environment is the subject of specific economic and energy policies aimed at generating sustainability also through coating in renewable energy [21]. The question of the environment must therefore also be considered in the light of energy policy issues, focusing on renewables also to counter the increase in the prices of raw materials [22]. The analysis of the sustainability of energy policies also has a very significant impact in determining economic growth policies [23]. Finally, it is also necessary to consider the role that the landscape plays in determining satisfaction with the environment [24].

3. The Econometric Model

An analysis of satisfaction with the environmental situation in the 20 Italian regions[1] was carried out in the period between 2004 and 2020. The data were analyzed using the following models, namely: Panel Data with Random Effects, Panel Data with Fixed Effects, Dynamic Panel, Pooled OLS, WLS. In particular, the variable Satisfaction with the Environmental Situation was analyzed, defined as the number of people aged 14 and over very or fairly satisfied with the environmental situation (air, water, noise) of the area in which they live out of the

[1]Regions are Piedmont, Aosta Valley/Aosta Valley, Liguria, Lombardy, Trentino-Alto Adige/Südtirol, Veneto, Friuli-Venezia Giulia, Emilia-Romagna, Tuscany, Umbria, Marche, Lazio, Abruzzo, Molise, Campania, Puglia, Basilicata, Calabria, Sicily, Sardinia.

total number of people aged 14 and over. In particular, the equation that has been estimated is indicated below, that is:

$$\begin{aligned}&\text{Satifaction With The Environmental Situation}_{it}\\&= a_1 + b_1(\text{People With At Least A Diploma})_{it}\\&\quad + b_2(\text{Gross Disposable Income Per Capita})_{it}\\&\quad + b_3(\text{Leisure Satisfaction})_{it}\\&\quad + b_4(\text{Dissatisfaction With The Landscape Of The Place Of Life})_{it}\\&\quad + b_5(\text{Perception Of The Risk Of Crime})_{it}\\&\quad + b_6(\text{Concerns About The Deterioration Of The Landscape})_{it}\end{aligned}$$

with $i = 20$ and $t = [2004; 2020]$.

The data show that the value of satisfaction with the condition of the environment is positively associated with the variables indicated below, namely:

• *People with at least a diploma*: it is a variable defined as the percentage of people aged 25 - 64 who have completed at least secondary school out of the total number of people of 25 - 64 years. There is a positive relationship between the value of satisfaction with the condition of the environment and the presence of people between 25 and 64 who have at least a diploma. It follows that the growth in satisfaction with the condition of the environment increases with the presence of the number of graduates. Schooling therefore tends to create the conditions for greater sensitivity towards the environment which can generate the conditions for greater environmental sustainability. Therefore, one of the levers that economic policy can use to improve sensitivity towards the environment is to invest in higher education for the population by increasing the percentage of graduates. It follows therefore that the economic policies of education have positive impacts also in terms of the sensitivity of the population to the environment.

• *Leisure satisfaction*: is a variable that analyzes the percentage of people aged 14 and over who declare themselves a lot of quite satisfied for the free time on the total of persons aged 14 and over. There is therefore a positive relationship between the value of satisfaction with the environmental condition and satisfaction with leisure time. It follows that evidently where there is a better environmental condition then it occurs that the population also declares greater satisfaction for free time. The presence, for example, of places that can be frequented in free time, such as lakes, mountains, woods, beaches, places where the population can use their free time. It follows therefore that the quality of the environment has a significant impact on the quality of life of the population also about the issue of leisure time. Leisure satisfaction therefore worsens where the quality of the environment decreases.

• *Concern about the deterioration of the landscape*: is a variable that considers the percentage of people aged 14 and over that indicates the degradation of the landscape caused by the excessive construction of buildings among the five most worrying environmental problems out of the total of people aged 14 and over. There is a positive relationship between satisfaction with the environmental

condition and concern for the deterioration of the environment. It follows that the population living in the Italian regions in which there is greater satisfaction with the environmental condition is also greater concern for the environment. That is, environmental awareness, the idea that the quality of the environment is a fact that affects individuals, people and even communities, tends to be associated with a greater concern for the deterioration of the environment. Therefore, if there is greater environmental awareness, concern for the future condition of the environment also tends to be growing in Table 1.

The results show that the value of satisfaction with the condition of the environment is negatively associated with the variables indicated below, namely:

• *Dissatisfaction with the landscape of the place of life*: it is a variable that considers the percentage of people aged 14 and over who declare that the landscape of the place of life is affected by evident deterioration out of the total of people aged 14 and over. There is therefore a negative relationship between the value of satisfaction with the environmental condition and dissatisfaction with the landscape of the place of life. It follows therefore that if satisfaction with the environmental situation increases, then dissatisfaction with the landscape of the place of life decreases. The report highlights the role of landscape as an essential component of the environment. It follows that it is not possible to create an improvement in the environmental situation without also improving the dimension of the landscape. It is also necessary that there are elements of anthropization of the landscape, which can, for example, be connected to the carrying out of agricultural activities, just as there are also elements of an architectural type that can have a significant impact in defining the landscape.

Table 1. Synthesis of the main econometrics results.

Estimation of Satisfaction with the Environmental Situation										
Variables	Pooled OLS		Fixed Effects		Causal Effects		Dynamic Panel		WLS	
	Coefficient	P-Vahie	Coefficient	P-Vahie	Coefficient	P-Vahie	Coefficient	P-Vahie	Coefficient	P-Vahie
Const	70.9473000000	***	70.48790000	***	65.119200000	***	−0.09674090	*	71.23980000	***
People with at least a diploma (2564 *years*)	0.3214680000	***	0.25891100	***	0.232862000	***	0.29181500	***	0.30743700	***
Gross disposable income per capita	−0.0008455620	***	−0.00102595	***	−0.000695252	***	−0.00088490	**	−0.00080381	***
Leisure satisfaction	0.2340520000	***	0.19465600	***	0.224036000	***	0.23026100	***	0.21354800	***
Dissatisfaction with the landscape of the place of life	−0.7924710000	***	−0.43233600	***	−0.533919000	***	−0.36624400	***	−0.78826200	***
Perception of the risk of crime	−0.3247880000	***	−13354100	***	−0.144361000	***	−0.13998500	***	−0.29638300	***
Concern about the deterioration of the landscape	0.4686340000	***	0.34071400	***	0.432440000	***	0.24649700	***	0.51222500	***
Satisfaction with the environmental situation (−1)							0.24174900	***		

• *Perception of the risk of crime*: is a variable that considers the percentage of families who declare the risk of crime in the area in which they live is very or quite high on the total of families. There is a negative relationship between the value of satisfaction with the condition of the environment and the perception of the risk of crime. In other words, in the areas where there is greater crime there is also a lower satisfaction of the environment. Living in places that are degraded from an environmental point of view are likely to generate very negative consequences in terms of safety and legality. It follows that both environmental sensitivity and safety and legality act on the same variable which substantially consists of social capital and human capital. It follows that if policy makers are interested in implementing economic policies aimed at increasing sensitivity towards the environment and citizens' attitude to legality, then it is necessary that they increase investments in human capital and social capital, for example through the institution, the insertion into the world of work, and the presence of a greater generalized trust in the population.

• *Gross disposable income per capita*: is the ratio between the gross disposable income of consumer households and the total number of residents. There is a negative relationship between the value of per capita disposable income and the value of satisfaction with the environmental condition. This negative relationship can be better understood considering that most of the per capita income is produced in the Italian regions that have the largest cities, the highest pollution levels, and a possibility of accessing the lowest environmental and landscape assets. This consideration is especially true for the regions of Northern Italy where the highest per capita incomes are concentrated and where, evidently, satisfaction with the environmental condition is also low. Satisfaction with the environmental condition is low especially in Lombardy, Emilia Romagna, and Piedmont where per capita incomes tend to be high. It follows that it would be possible to create an element of environmental discount factor, or to identify a sum that should be added to income to discount the effects of an unsatisfactory environmental condition in the absence of adequate active economic policies.

4. Clusterization

The k-Means algorithm for clustering the data was then used to verify the presence of a set of groupings in the Italian regions by value of satisfaction with the environmental condition. However, it must be considered that the k-Means algorithm is an unsupervised algorithm and therefore to choose the optimal number of clusters it was necessary to use the Silhouette coefficient. The Silhouette coefficient is a value that varies between −1 and 1. The value of the Silhouette coefficient is assigned both to the individual elements of the cluster and to the entire cluster. A value of the Silhouette coefficient was chosen such that it complied with the following two conditions as shown in **Figure 1**:

• *Choose the largest number of clusters*;

• *Make sure that no element of any single cluster has a negative Silhouette coefficient value.*

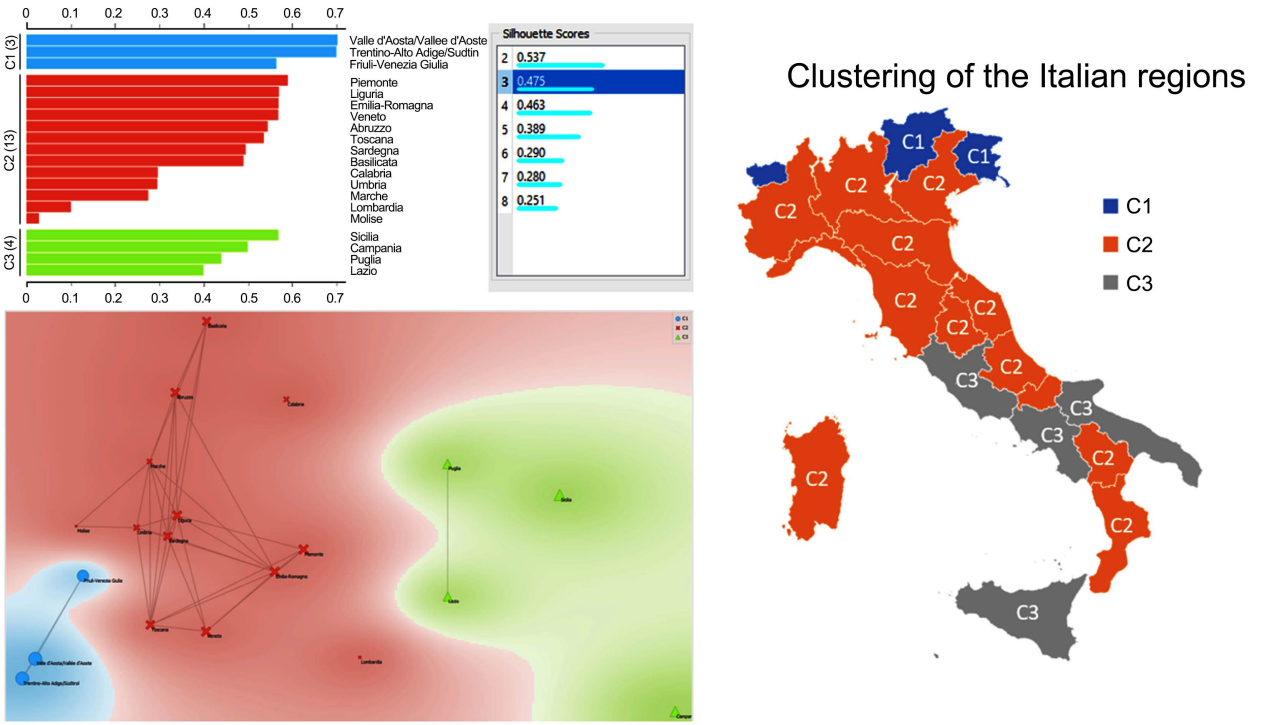

Figure 1. Clustering of the italian regions.

The application of these conditions allows to have a representation by clusters able to represent an adequate heterogeneity of the observed variable ensuring that none of the analyzed elements is negative in terms of the Silhouette coefficient.

Therefore, a clustering value equal to 3 was chosen. Clusters thus formed were derived:

- *Cluster 1*: Valle D'Aosta, Trentino-Alto Adige, Friuli-Venezia Giulia;
- *Cluster 2*: Piedmont, Liguria, Lombardy, Veneto, Emilia-Romagna, Tuscany, Umbria, Marche, Abruzzo, Molise, Basilicata, Calabria, Sardinia;
- *Cluster 3*: Lazio, Campania, Puglia, Sicily.

From the point of view of clustering, it is possible to carry out an analysis aimed at constructing the ordering of clusters based on the median value of satisfaction with the environmental condition. In this sense it appears that the median value of satisfaction for the environmental condition in cluster 1-C1 is equal to 85.3, while the median value of cluster 2-C2 is equal to 76.2 and the corresponding value of cluster 3 is 64.4. The ordering of the clusters is therefore as follows: C1 > C2 > C3.

The cluster analysis therefore shows an image of the Italian regions with a central North characterized by high satisfaction values for the environmental condition and a South having low values for the same variable. It follows therefore that in the northern regions, especially in the mountain regions, there is a high level of satisfaction with the landscape as happens in Friuli Venezia Giulia, Trentino Alto Adige and Valle d'Aosta. In the southern regions, on the other

hand, there is less satisfaction with the satisfaction of the environmental condition. The low satisfaction of the citizens of Southern Italy for the condition of the environment could also be due to the lack of adequate green spaces in charge, as happens for example for national and regional parks and protected areas. Furthermore, it must be considered that in the mountain regions of Northern Italy and in the Apennine regions of Central Italy there are mountain communities that often have specific tasks in protecting the environment and the landscape. It follows therefore that the presence of economic environmental policies determined on a regional basis can have a significant impact in protecting certain geographic areas also in southern Italy to increase satisfaction with the environmental condition. Finally, further considerations are necessary with reference to the presence of urban plans and the regulation of pollution sources that can significantly reduce the ability of the population to use a certain territory from a naturalistic point of view.

5. Machine Learning and Prediction

A comparison was then made between eight different machine learning algorithms for predicting the future value of satisfaction with the environmental condition. In particular, the algorithms have been selected based on their ability to maximize the R-squared and to minimize statistical errors. The algorithms were trained using 70% of the available data while the remaining 30% was used for the actual prediction. Based on the score obtained in the individual rankings, the following algorithm order was determined:

- *Tree Ensemble Regression* with a payoff value of 5;
- *Gradient Boosted Tree Regression* with a payoff value of 10;
- *Simple Regression Tree* with a payoff value of 15;
- *Random Forest Regression* with a payoff value of 23;
- *ANN-Artificial Neural Network* with a payoff value of 25;
- *PNN-Probabilistic Neural Network* with a payoff value of 27;
- *Linear Regression* with a payoff value of 36;
- *Polynomial Regression* with a payoff value of 39;

It follows that using the Tree Ensemble Regression the following predictions result based on historical data, that is as shown in **Table 2**:

- *Abruzzo* with an increase from an amount of 74.60 up to a value of 77.19 units or equal to an amount of 2.59 units equal to a value of 3.47%;
- *Basilicata* with a decrease from an amount of 78.10 units up to a value of 75.99 units or equal to a value of −2.11 units equal to a variation of −2.17%;
- *Calabria* with a decrease from an amount of 69.70 units up to a value of 67.21 units or equal to an amount of −2.49 units equal to a variation of −3.57%;
- *Campania* with an increase from an amount of 56.40 units up to a value of 64.99 units or equal to a variation of 8.59 units equal to a value of 15.23%;
- *Emilia Romagna* with a variation from an amount of 72.80 units up to a value of 76.68 units or equal to a value of 3.88 units equal to a variation of 5.33%;

Table 2. Prediction with historical data.

Prediction with Historical Data with Tree Ensemble Regression				
Region	2019	Prediction	Absolute Variation	Percentage Variation
Abruzzo	74.60	77.19	2.59	3.47
Basilicata	78.10	75.99	−2.11	−2.71
Calabria	69.70	67.21	−2.49	−3.57
Campania	56.40	64.99	8.59	15.23
Emilia Romagna	72.80	76.68	3.88	5.33
Friuli Venezia Giulia	85.30	81.31	−3.99	−4.68
Lazio	64.70	67.30	2.60	4.02
Liguria	78.90	66.53	.12,37	−15.68
Lombardy	69.50	73.70	4.20	6.04
Marche	80.70	67.66	−13.04	−16.16
Molise	81.20	78.56	−2.64	−3.25
Piedmont	70.70	79.90	9.20	13.01
Puglia	65.90	73.67	7.77	11.79
Sardinia	76.20	67.60	−8.60	−11.29
Sicily	64.10	78.21	14.11	22.01
Tuscany	79.00	74.11	−4.89	−6.19
Trentino-Alto Adige/Siidtirol	89.50	83.94	−5.56	−6.21
Umbria	77.90	77.96	0.06	0.08
Aosta Valley/Aosta Valley	84.20	85.84	1.64	1.95
Veneto	73.10	73.45	0.35	0.48
Mean	74.63	74.59	−0.03	−0.05

- *Friuli-Venezia Giulia* with a decrease from an amount of 85.30 units up to a value of 81.31 units or equal to a variation of −3.99 units equal to a value of 4.68%;
- *Lazio* with an increase from a value of 64.70 units up to a value of 67.30 units or equal to a variation of 2.60 units equal to an amount of 4.02%;
- *Liguria* with a decrease from an amount of 78.90 units up to a value of 66.53 units or equal to a value of −12.37 units equal to a value of −15.68%;
- *Lombardy* with an increase from an amount of 69.50 units up to a value of 73.70 units or equal to a variation of 4.20 units equal to a value of 6.04%;
- *Marche* with a decrease from an amount of 80.70 units up to a value of 67.66 units or equal to a variation of −13.04 units equal to an amount of −16.16%;
- *Molise* with a decrease from an amount of 81.20 units up to a value of 78.56 units or equal to a variation of −2.64 units equal to a value of −3.25%;
- *Piedmont* with an increase from an amount of 70.70 units up to a value of 79.90 units or equal to a value of 9.20 units equal to an amount of 13.01%;

• *Puglia* with an increase from an amount of 65.90 units up to a value of 73.67 units or equal to a variation of 7.77 units equal to a value of 11.79%;

• *Sardinia* with a decrease from an amount of 76.20 units up to a value of 67.60 units or equal to a variation of −8.60 units equal to a value of −11.29%;

• *Sicily* with an increase from an amount of 64.10 units up to a value of 78.21 units or equal to a value of 14.11 units equal to a variation of 22.01%;

• *Tuscany* with a decrease from an amount of 79.00 units up to a value of 74.11 units or equal to a variation of −4.89 units equal to −6.19%;

• *Trentino-Alto Adige* with a decrease from an amount of 89.50 units up to a variation of 83.94 units or equal to a variation of −5.56 units equal to an amount of −6.21%;

• *Umbria* with an increase from an amount of 77.90 units up to a variation of 77.96 units or equal to a value of 0.06 units equal to a value of 0.08%;

• *Valle d'Aosta* with an increase from a value of 84.20 units up to a value of 85.84 units or equal to a variation of 1.64 units equal to a value of 1.95%;

• *Veneto* with an increase from an amount of 73.10 units up to a value of 73.45 units or equal to a variation of 0.35 units equal to a value of 0.48%;

On average for the regions indicated, the value of satisfaction with the environmental condition is expected to decrease from an amount of 74.63 units up to a value of 74.59 units or equal to a value of −0.03 units equal to a value of −0.05%.

6. Augmented Data

A prediction was then made with augmented data. That is, the prediction data was used to make a further prediction. Also, in this case a comparative analysis was carried out between eight different machine learning algorithms for the prediction of the satisfaction value for the environmental condition. It should be considered that 70% of the data was used for the training of the algorithms while the remaining 30% of the data is used for the actual prediction. The algorithms were selected based on their ability to maximize the R-squared value and minimize statistical errors. Therefore, the following ordering of the algorithms derives, namely as shown in **Table 3**:

• *Tree Ensemble Regression* with a payoff value of 7;

• *Random Forest Regression* with a payoff value of 12;

• *PNN-Probabilistic Neural Network* with a payoff value of 14;

• *Gradient Boosted Tree Regression* with a payoff value of 21;

• *Simple Regression Tree* with a payoff value of 26;

• *Polynomial Regression* with a payoff value of 31;

• *ANN-Artificial Neural Network* with a payoff value of 32;

• *Linear Regression* with a payoff value of 37.

Through the application of the Tree Ensemble Regression, which turns out to be the best predictor, the following predictions result as shown in **Table 4**:

• *Calabria* with an increase from an amount of 67.21 up to a value of 72.10 units or equal to a variation of 4.89 units equal to a value of 7.28%;

Table 3. Ranking of machine learning algorithms trained with augmented data.

Ranking of machine learning algorithms trained with augmented data						
Algorithms	**R^2**	**Mean absolute error**	**Mean squared error**	**Root mean squared error**	**Mean signed difference**	**Total**
Tree Ensemble Regression	1	1	1	1	3	7
Random Forest Regression	2	2	2	2	4	12
PNN	3	3	3	3	2	14
Gradient Boosted Tree Regression	4	4	4	4	5	21
Simple Regression Tree	5	8	7	5	1	26
Polynomial Regression	6	6	6	6	7	31
ANN	8	5	5	8	6	32
Linear Regression	7	7	8	7	8	37

Table 4. Percentage and absolute variation in the prediction with historical data and augmented data.

Regions	**Prediction with Historical Data**	**Prediction With Augmented Data**	**Absolute Variation**	**Percentage Variation**
Calabria	67.21	72.10	4.89	7.28
Lombardy	73.70	72.48	−1.23	−1.66
Piedmont	79.90	73.01	−6.88	−8.61
Puglia	73.67	71.50	−2.16	−2.94
Valle d'Aosta	85.84	80.56	−5.29	−6.16
Veneto	73.45	73.81	0.36	0.49
Mean	75.63	73.91	−1.72	−1.93

- *Lombardy* with a decrease from a value of 73.70 units up to a value of 72.48 units or equal to a value of −1.23 units equal to a value of −1.66%;
- *Piedmont* with a decrease from an amount from a value of 79.90 units up to a value of 73.01 units or equal to a value of −6.88 units equal to a value of −8.61%;
- *Puglia* with a decrease from an amount of 73.67 units up to a value of 71.50 units equal to a value of −2.16 units equal to a value of −2.94%;
- *Valle d'Aosta* with a decrease from an amount of 85.84 units equal to a value of 80.56 units or equal to a variation of −5.29 units equal to a value of −6.16%;
- *Veneto* with an increase from an amount of 73.45 units up to a value of 73.81 units or equal to a variation of 0.36 units equal to a variation of 0.49%;

On average, for the regions considered using augmented data, a reduction is expected from an amount of 75.63 units up to a value of 73.91 units or equal to a variation of −1.72 units equal to a value of −1.93%.

However, it must be considered that in the comparison between the prediction with historical data and the prediction with augmented data there is a variation of the average of the statistical errors from a value of 0.04 up to a value of

0.18 or equal to a variation of 0.14467225447537.

7. Conclusions

In the following article, the "*Satisfaction Value for the Environmental Condition*" in the 20 Italian regions between 2004 and 2020 was estimated using ISTAT-BES data. The environmental issue is increasingly relevant from the point of view both economic policies aimed at increasing satisfaction with the quality of life, and issues related to the sustainability of energy policies which have returned to the center of analysis in Europe following the invasion of Ukraine by Russia in 2022. The analysis of the scientific literature shows the centrality of the environment for the increase of life satisfaction both in urban and peripheral areas. Economic energy policies oriented towards renewables can have a positive impact both in reducing the price of raw materials and in creating an environment that is sustainable.

The data were analyzed using the following econometric techniques, namely: Panel Data with Random Effects, Panel Data with Fixed Effects, Dynamic Panel, Pooled OLS, WLS. The results show that satisfaction with the environmental situation is positively associated with the following variables "*People with at least high school diploma*", "*Satisfaction with leisure time*", "*Concern for the deterioration of the landscape*" and negatively associated with "*Gross disposable income per capita*", "*Dissatisfaction with the landscape of the place of life*", "*Perception of the risk of crime*". From a metric point of view, the variable that tends to have a greater impact on satisfaction with the environmental condition in the Italian regions is schooling. On the contrary, the presence of crime prevents the population from enjoying the environment as a public good for the satisfaction of life.

A cluster analysis was then carried out using the unsupervised k-Means algorithm optimized through the Silhouette coefficient and 3 clusters were found. The cluster analysis shows that the regions of Southern Italy are far behind in terms of satisfaction with the environment despite being endowed with landscape and naturalistic assets. It follows that the aspects of human, social and institutional capital, which are scarcer in Southern Italy than in the richer regions of Central and Northern Italy, have an impact on preventing southern Italians from enjoying the environment as an element of life satisfaction.

A comparative analysis was then carried out between eight different machine learning algorithms to predict the trend of satisfaction by environmental situation. The analysis showed that the Tree Ensemble Regression algorithm is the best predictor and estimates a reduction of the variable of 0.05%. Subsequently, using augmented data, a further prediction was made with an estimated result equal to −1.93%. Predictive analysis shows that satisfaction with the environment may significantly decrease in the future. In this regard, it is necessary that policy makers implement both national and regional economic policies to ensure that the population is more satisfied with the conditions of the environment,

triggering positive reactions also on the general subjective well-being index.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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