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INVESTIGATING THE RELATIONSHIP BETWEEN GREEN TRANSITION AND SOCIO-ECONOMIC DIMENSIONS – A WAY TO A SUSTAINABLE FUTURE

Abstract:

The complex relationship between green transition and socio-economic factors implies a detailed and comprehensive analysis of the interdependencies between the indicators. The employment and unemployment variables will be particularly affected. Amounting research shows that the transformation to "green" jobs, if not supported by adequate policies, will put the labour market at risk. On the one hand, the need for new skills means higher public costs, and on the other hand, the drive to reduce carbon emissions, if not accompanied by unemployment control, will also put economic growth at risk. This implies a gradual transformation of the countries, which in turn requires updated social and fiscal pacts. Such countries must be adapted to the future, must tackle modern risk structure, must ensure the expansion of the scope of rights and urgently face the challenges of low productivity, social vulnerability and inequality, institutional weakness and technological and climate change.

Keywords:

Green transition, Labour market, Social-economic dimension, Unemployment, Growth, CO2 emissions

JEL Classification: E24, Q01, G28

1 Introduction

In this study, we analysed the relationship between the green transition and the socio-economic dimensions of the global economic system. By utilizing data obtained from the reputable World Bank, we aim at underpinning the relation between environmental sustainability and various socio-economic factors. Specifically, we focus on three key indicators: CO2 per capita, GDP per capita and Total Unemployment Rate. Through employing a range of analytical techniques including correlation analysis, regression analysis, clustering, dimensional reduction, and manifold analysis, we aim to unravel the connections between green practices and the social and economic aspects of the global economy. The issue of green transition is complex and requires substantial planning and investment. Nevertheless, the short-term costs may be more apparent than the long-term benefits. Short-term political cycles alongside vested interests can impact policies aimed at tackling these complex, long-term challenges and can result in governments' detachment from public opinion. It is therefore essential that governments elaborate a long-term vision for their actions and that the green transition is supported by appropriate socio-economic policies, or else it will put fiscal and social sustainability at risk.

2 Literature review

The series of crises have accentuated the social discontent and greater aspirations for higher living standard, emphasizing the fact that the pillars supporting socio-economic progress during the years of prosperity need reconsideration. The rise of social discontent, the declining macroeconomic indicators, the lack of clear social policies combined with the necessity for a green transformation confirmed the need to achieve a new, comprehensive consensus and to overcome the gap between society and public institutions. A new social contract which balances environmental sustainability with the needs of the various socio-economic groups, territories and generations is crucial for the future sustainable development. What is more, social discontent is indeed partially aggravated by the impact of the crisis, but it is also structural and multidimensional in nature and can be interpreted through demands for better jobs, quality public services, greater political representation and conservation efforts. Such voicing of social grievances across Europe highlights the imperative actions for EU countries: to update their social contract to recover from the COVID-19 crisis in a more sustainable and inclusive way (OECD et al., 2021). It should be noted that there is increasing evidence that climate change can also cause significant damage to production systems with notable impacts on labor markets and working conditions (EC, 2022). The costs of climate change are likely to vary significantly across Member States, with southern and coastal Member States being more negatively affected (Giordani, 2014).

Through extensive support for green policies, as well as awareness of climate change, the green transition can become the backbone of a new social contract which will seek to increase the well-being of citizens. This modern social contract must review the current development model from a multidimensional perspective, placing the green dimension at the focus. This would lead to progress in terms of more sustainable production and consumption strategies, stronger social

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assistance systems adapted to the challenges of the ecological transition, and green development financing models to support these efforts. Due to the fact that green policies can have asymmetric impacts across socio-economic groups, territories and generations, adopting a cross-sectoral approach will be crucial to balance the varying costs and benefits and gain support – and avoid backlash – of the green agenda (OECD, 2022). In the context of the COVID-19 crisis, the role of the state is expanding, mostly through temporary interventions; an up-to-date social contract could face the need to adapt and strengthen state capacity in the medium and long term. Moreover, research (EC, 2022) indicates that Bulgaria, together with Romania and Poland, will require the most significant funds for employment restructuring.

A green, inclusive and fair transition calls for institutional mechanisms to promote dialogue and reach consensus on reforms. Otherwise, stakeholders may impede change (Arent et al., 2017). In this line of thought, the green transition may bring not only benefits but also significant costs and negative impacts for specific socio-economic groups at least in the short term, including higher unemployment. Reduction of such short-term costs and awareness of vulnerable groups can strengthen confidence in government actions and generate feelings of responsiveness and trustworthiness among the population.

Policymakers must take these dynamics into account when considering how to manage the green transition in order to make it possible and fair. Among other considerations, it is important to identify and involve key stakeholders in the policy-making process from the very beginning; to understand the socio-political context to adjust the speed and scale of transition appropriately; to develop a clear communication strategy based on key results: to establish a comprehensive set of policies to support people during the transition and to avoid the perception that certain groups or sectors are disproportionately affected by it. The achievement of a fair green transition will require the enhancement of sustainability policy coherence across levels and sectors of government. Given the complex interrelationships between economic, social and environmental challenges, policy coherence can help policymakers better comprehend the impacts and side effects of the policies.

Policy coherence has three main objectives (Morales, 2018). The first one is to help promote synergies and minimize compromises between sectors. The second one is to help reconcile local, regional and national policy objectives with goals set internationally and avoid fragmented responses. Most policies and objectives related to climate change and sustainable development are a shared responsibility between levels of government or are critically dependent on local action. It is therefore essential to promote coordination and alignment of objectives. The third one is to address the cross-border and long-term effects of policies. In particular, informed choices about sustainable development must acknowledge the long-term impact of policy decisions on the well-being of future generations.

Effective and inclusive institutional and governance mechanisms are important to tackle policy interactions (OECD, 2021).

In order to guarantee a long-term result, horizontal green policies need enhancement, but also involving key stakeholders within and outside public institutions. It is the analysis that will reveal

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the multidimensional relationship among the indicators and will outline the possible route of future development towards an inclusive and green transition.

3 Methodology

In order to accomplish the research objectives, we based the article on systematic methodology which can be outlined as follows:

Data Collection and Data Preprocessing: the necessary data from the World Bank is accessed through Python Library and subsequently collected. The information sourced includes the following indicators: CO2 per capita, GDP growth and Total Unemployment Rate. Comprehensive coverage is ensured by considering all countries and focusing on the year 2020. Prior to analysis, we conducted data preprocessing. This involves identifying and addressing any missing data or outliers. By applying robust cleaning and standardization techniques, such as StandardScaler, an attempt is made to ensure data consistency and comparability across indicators.

Correlation Analysis: a correlation analysis is conducted to examine the relationships between the selected indicators. This statistical method allows us to gauge the strength and direction of the associations, providing valuable insights into the connections between environmental sustainability and socio-economic dimensions.

Regression Analysis: we construct regression analysis models to explore the relationship between dependent variables, such as GDP per capita, and independent variables including CO2 per capita and Total Unemployment Rate. Through this analysis, we seek to establish how changes in the independent variables influence the dependent variable, thus unravelling the socio-economic implications of the green transition.

Clustering: by the application of clustering techniques, specifically K-means clustering, we aim at identifying distinct groups or patterns among countries based on the selected indicators. By uncovering similarities or differences in socio-economic and environmental profiles across countries, this analysis facilitates a deeper understanding of the diverse impacts and responses to the green transition.

Graphical Analysis: Graphical analysis is conducted to visually explore the relationships and patterns within the dataset. The use of scatter plots, line plots, and other visualization techniques is intended to depict the interrelationships between the variables and to gain intuitive insights into the data.

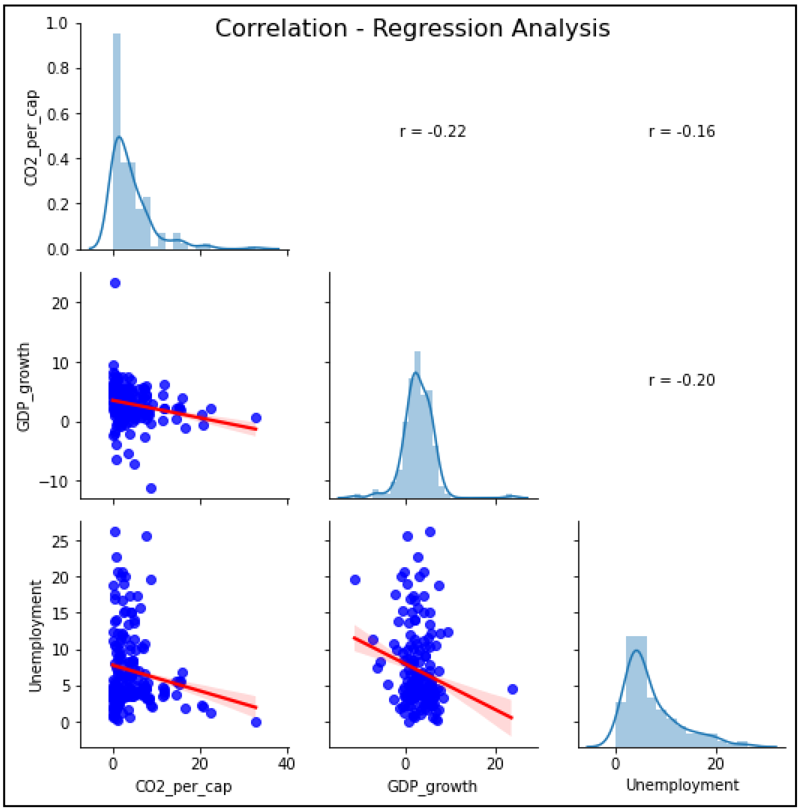
Dimensional Reduction: in the methodology of the analysis it is necessary to manage the dimensionality of the dataset and identify the most influential components. It requires the application of Principal Component Analysis (PCA). This technique enables us to extract key dimensions contributing to the overall variation in the data. By reducing the complexity, we gain valuable insights into the socio-economic factors most closely associated with the green transition.

Manifold Analysis: with the purpose to visualize and comprehend the relationships among data points in a lower-dimensional space, we utilize Manifold Analysis techniques such as t-SNE. This analysis helps to reveal underlying structures, patterns, and clusters within the dataset, providing a comprehensive understanding of the interconnections between the green transition and socio-economic dimensions.

4 Research Procedure and Results

Figure 1 presents a correlation subplot which shows the pairwise relationships between each of the indicators. Each indicator is plotted against the others in a scatterplot, allowing for a visual examination of their potential correlation. To enhance the analysis, a linear regression line is added to each scatterplot subplot, providing insights into the strength and direction of the relationship.

Figure 1 Corelation matrix graph of CO2 per capita, GDP growth and Total Unemployment Rate for 2020 year.



***Source: World Bank**.*

Additionally, the regression line is accompanied by the coefficient of determination (R-squared, r2) score. The R-squared score indicates the proportion of variance explained by the linear

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regression model. It ranges from 0.06 to 0.22 in our analysis, suggesting varying degrees of correlation between the indicators.

The results of this analysis indicate that there is no exact pattern of correlation among the selected indicators. The observed R-squared scores signify moderate to weak correlations between the variables. As a result, further analysis is warranted to better understand the complex relationship between the green transition and socio-economic dimensions.

Overall, Figure 1 serves as an initial exploration to identify potential connections between the indicators. It highlights the need for additional analyses, such as clustering, dimensional reduction, and manifold analysis, to unravel the intricate interplay between the green transition and socio-economic factors.

Since no clear relationship is observed between the individual indicators, which are fourth in number, it is necessary to deepen the analysis by reducing the number of dimensions. For this reason, we switch to PCA analysis. In this study, Principal Component Analysis (PCA) is employed as a dimensionality reduction technique to explore the relationships between the selected indicators related to the green transition and socio-economic dimensions. Additionally, StandardScaler is applied as a preprocessing step to ensure the features are standardized and contribute equally to the analysis.

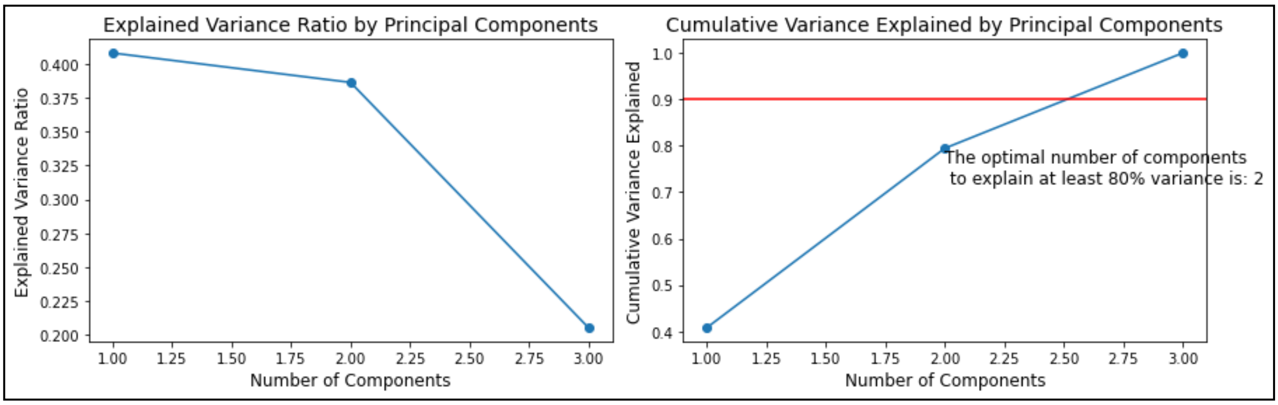
StandardScaler is used to standardize the features by removing the mean and scaling them to unit variance. This step is crucial when dealing with variables measured on different scales. By standardizing the features, the PCA analysis can accurately capture the most significant patterns and variations in the data.

PCA, on the other hand, identifies the principal components that explain the maximum variance in the data. These components represent linear combinations of the original features and can help reduce the dimensionality of the dataset. By reducing the dimensionality, PCA enables a more concise representation of the data while preserving the most relevant information.

To ensure the effectiveness of the PCA analysis, it is recommended to apply StandardScaler before performing PCA. This is because PCA is sensitive to the scale of the features, and by standardizing the data, we mitigate the dominance of features with larger magnitudes. This step allows PCA to consider each feature equally and avoid skewing the results based on scale differences.

In Figure 2, the results of the PCA analysis are presented through two subplots. The first subplot illustrates the "Explained Variance Ratio by Principal Components," while the second subplot shows the "Cumulative Variance Explained by Principal Components." These plots provide valuable insights into the optimal number of components needed to explain a significant portion of the variance in the data.

Figure 2 Explained and cumulative variance graph of PCA analysis



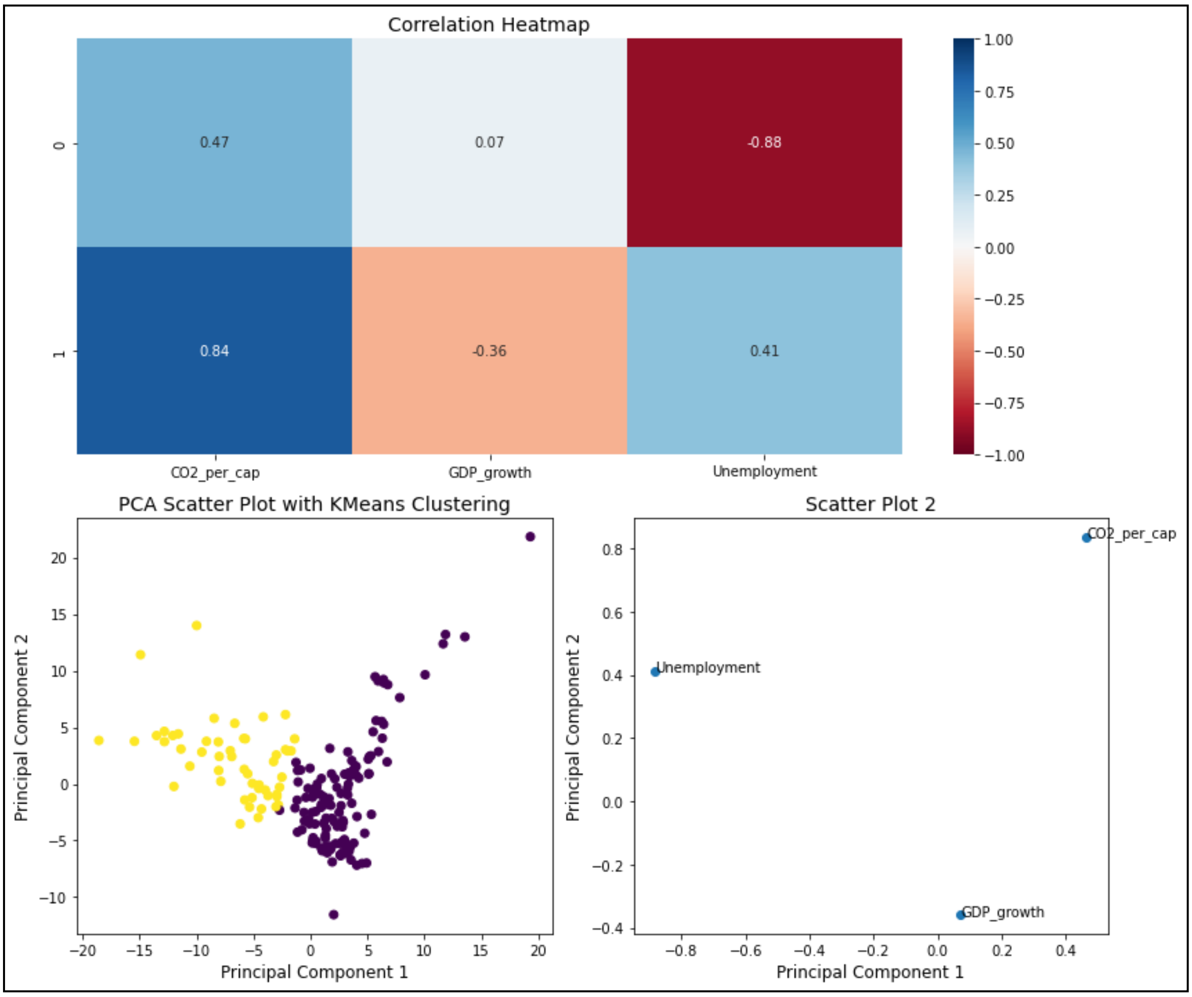
Source: Own calculations.

The "Explained Variance Ratio by Principal Components" plot demonstrates the proportion of variance explained by each principal component. Each point on the plot represents a principal component, and the corresponding value indicates the percentage of variance explained. This plot helps in identifying the principal components that contribute the most to the overall variance in the data.

The second subplot, "Cumulative Variance Explained by Principal Components," depicts the cumulative variance explained as we increase the number of principal components. This plot allows us to determine the point at which adding more components does not significantly contribute to the overall variance explained. In our analysis, we observe that reaching at least 90% of the cumulative variance requires the use of three principal components.

Based on the results from the PCA analysis, it is determined that the optimal number of components to explain at least 80% of the variance in the data is two. Therefore, in the subsequent steps of the analysis, these two dimensions will be utilized to capture the most significant patterns and variations related to the green transition and socio-economic dimensions.

Figure 3 Corelation heatmap and PCA clustering.



***Source: World bank*.**

In the next step of the analysis, considering the absence of clear patterns between the indicators and the PCA analysis revealing two components, Figure 3 presents three subplots to further explore the relationships.

The first subplot illustrates the correlation between each component and the indicator columns. The results indicate that the first component has a correlation of 0.47 with CO2 per capita and -0.88 with unemployment. This suggests that in some countries, reducing unemployment comes at the expense of higher CO2 emissions per capita, indicating a trade-off between social development and environmental impact. This trade-off reflects the price of development. On the other hand, the second component shows a correlation of 0.84 with CO2 per capita, -0.36 with GDP, and 0.41 with unemployment. This implies that to achieve higher GDP growth, reducing unemployment and CO2 emissions per capita are necessary. These correlations highlight the complex interplay between economic growth, employment rates, and environmental sustainability.

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The second graph in Figure 3 presents a scatter plot with K-means cluster analysis using two clusters. However, no clear pattern or distinct clusters can be observed, indicating that the relationships between the variables do not exhibit a straightforward grouping.

The third graph shows the position of each column in the two-dimensional space of the first and second components. Again, no discernible pattern or clustering can be observed, indicating that the relationships between the indicators may not be linear. This suggests that further analysis, such as non-linear techniques like t-SNE (t-Distributed Stochastic Neighbor Embedding), may be necessary to uncover more intricate relationships and patterns within the data.

Overall, the findings from Figure 4 highlight the complexity of the connections between the indicators and suggest the need for more advanced analysis techniques to capture the underlying relationships and dynamics.

The analysis performed in the next step aimed to address the limitations of PCA in visualizing the K-means clusters. The methodology employed t-SNE, a non-linear dimensionality reduction technique, to explore potential non-linear connections in the data. The results, presented in Figure 3, utilized different hyperparameters for t-SNE, including perplexities of 5, 10, and 20, and random seeds of 42, 100, and 200.

The t-SNE analysis suggests that the countries can be categorized into two distinct groups based on their performance in these indicators. The clustering helps to identify the relationship and trade-off between development and green/social growth.

Bulgaria is marked with a red dot, which allows it to be visualized on an equal footing with the rest of the countries in the context of the first and second components. It is important to note that the interpretation of the clusters and their underlying patterns should be further investigated.

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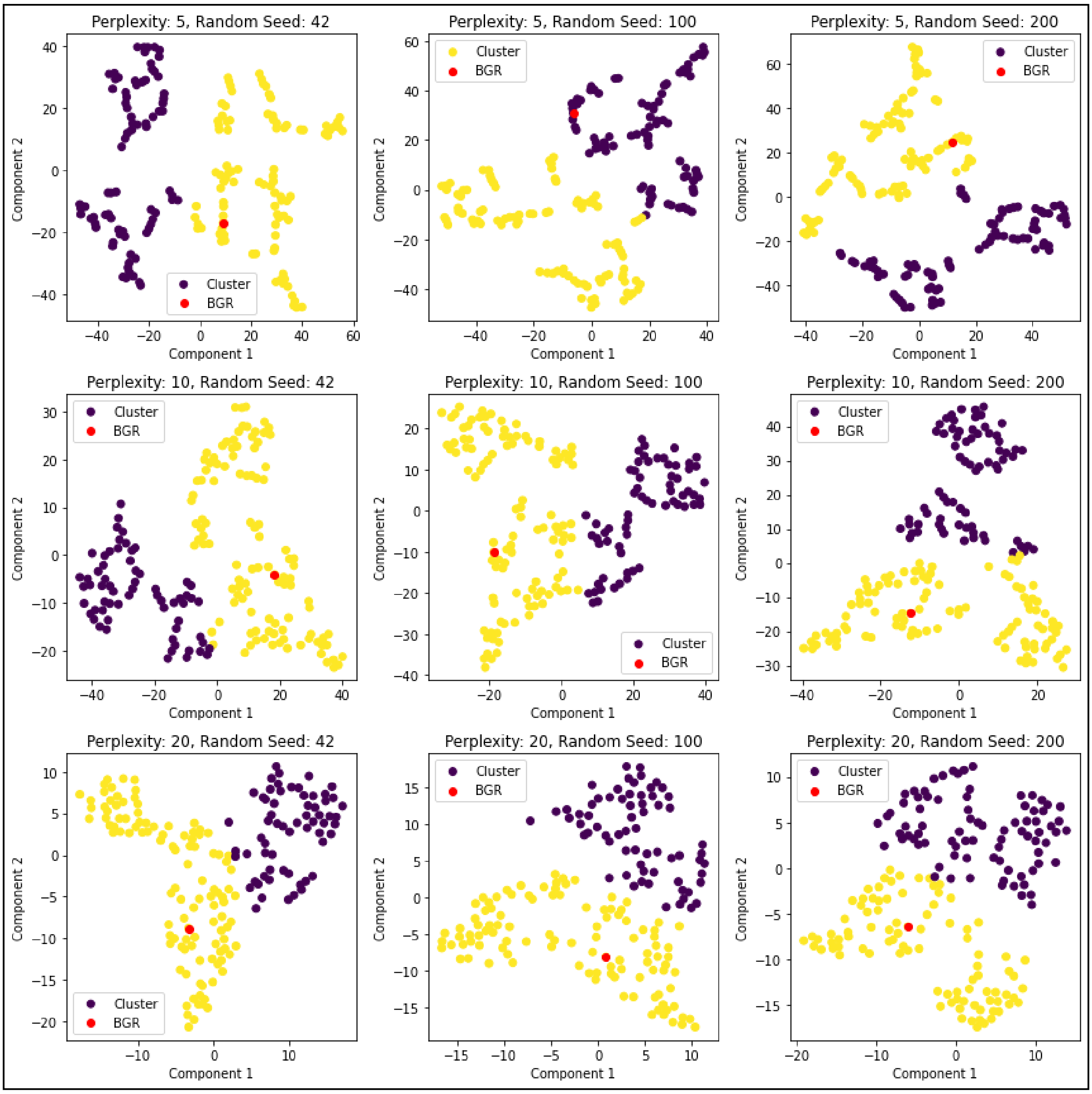
Figure 4 TSNE visualization of hyperparameter combinations.



Source: World bank.

5 Conclusion

By adopting a multi-faceted approach encompassing correlation analysis, regression analysis, clustering, dimensional reduction, and manifold analysis, our study seeks to unravel the intricate relationship between the green transition and socio-economic dimensions. Through these analyses, we gain insights into the associations, impacts, and implications of environmental sustainability on the global socio-economic landscape. By understanding these connections, policymakers and stakeholders can make informed decisions and foster a more sustainable and inclusive future.

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