

University of Mary Washington

Eagle Scholar

Research and Creativity Symposium

Research Symposia

4-15-2022

Adjusting Environmental Performance Index Scores to Account for Gross National Income

Rory Black

Follow this and additional works at: <https://scholar.umw.edu/rcd>



Part of the [Mathematics Commons](#)

Recommended Citation

Black, Rory, "Adjusting Environmental Performance Index Scores to Account for Gross National Income" (2022). *Research and Creativity Symposium*. 164.

<https://scholar.umw.edu/rcd/164>

This Poster is brought to you for free and open access by the Research Symposia at Eagle Scholar. It has been accepted for inclusion in Research and Creativity Symposium by an authorized administrator of Eagle Scholar. For more information, please contact archives@umw.edu.

Adjusting Environmental Performance Index Scores to Account for Gross National Income

Rory Black – Department of Mathematics, University of Mary Washington
 Faculty Advisor: Debra Hydorn, PhD



Abstract

I examined the Environmental Performance Index (EPI) report assembled by Yale University to address the need for environmental action. In this report, Yale University ranks countries across the globe on their environmental performance based on various indicators. I was interested in determining if all countries were ranked on a fair scale. Yale University acknowledges that each country varies in their economic resources measured by GDP but did not adjust for that in their scoring. I utilized factor analysis and cluster analysis to first analyze patterns and groupings that appeared the countries. I then standardized the original rankings with respect to region and then by Gross National Income (GNI). The new rankings revealed that some countries performed better than in the original report when considering their regional or GNI grouping. Since environmental decline is such a big issue in our global community, it only seems fair to give countries the opportunity to demonstrate that they are making efforts while accounting for each country's current environmental or economic situation.

Introduction

The EPI score is calculated using 34 different indicators. These indicators are organized into 11 overarching groups.

Environmental Health

- **AIR** – Air Quality
- **H2O** – Sanitation & Drinking Water
- **HMT** – Heavy Metals
- **WMG** – Waste Management

Ecosystem Vitality

- **BDH** – Biodiversity & Habitat
- **ECS** – Ecosystem Services
- **FSH** – Fisheries
- **CCH** – Climate Change
- **APE** – Pollution Emissions
- **AGR** – Agriculture
- **WRS** – Water Resources



Figure 1. Pie chart displaying the categorization of environmental indicators.

Image courtesy of Yale University

Countries & Regions

The report includes 180 countries from 8 different regions. The 8 regions and counts for each region are listed below.

- **Asia-Pacific** (25)
- **Eastern Europe** (19)
- **Former Soviet States** (12)
- **Global West** (22)
- **Greater Middle East** (16)
- **Latin America & Caribbean** (32)
- **Southern Asia** (8)
- **Sub-Saharan Africa** (46)

Data Exploration

Cluster Analysis

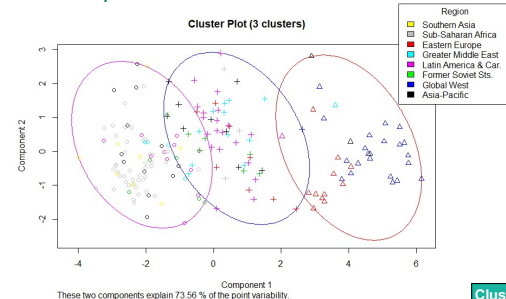


Figure 2. Cluster plot displaying the ideal three clusters

Upon examining elbow plots for k-means clustering, three clusters appeared to be the ideal number of clusters to analyze. The breakdown of the number of countries from each region in each cluster is below. Although region appears to have some impact on the similarities between countries, there is not an exact divide among regions.

Region	Cluster 1	Cluster 2	Cluster 3
Asia-Pacific	13	3	9
Eastern European	0	11	8
Former Soviet States	6	0	6
Global West	0	21	1
Greater Middle East	4	1	11
Latin America & Caribbean	11	1	20
Southern Asia	8	0	0
Sub-Saharan Africa	43	0	3

Figure 3. Table displaying the representation of regions across clusters

Cluster	EPI	AIR	H2O	HMT	WMG	BDH	CCH	APE	AGR	WRS
1	34.50	28.38	24.73	37.56	7.54	55.27	37.52	43.89	35.55	2.58
2	71.24	77.93	87.39	84.44	86.41	75.85	69.53	91.91	51.72	76.31
3	48.14	45.94	54.91	55.56	48.96	49.52	55.08	66.95	36.96	15.26

Figure 4. Table displaying the mean sub scores of various indicators by cluster (minimums of each indicator are highlighted)

Methods

Adjustment for Region

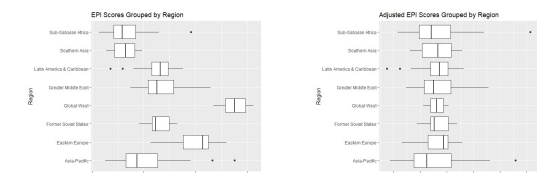


Figure 5. Grouped box plots corresponding to region

Gross National Income (GNI) Classification

GNI Group	Range
Low Income Economy	\$1,045 or less
Lower-Middle Income Economy	\$1,046 - \$4,095
Upper-Middle Income Economy	\$4,096 - \$12,695
High Income Economy	\$12,696 or more

Figure 6. Table displaying the ranges used to categorize countries by Gross National Income

Adjustment for Gross National Income (GNI)

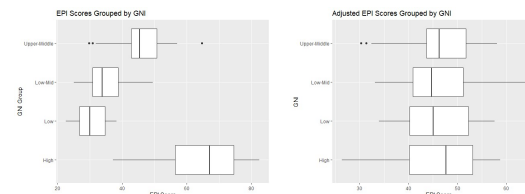


Figure 7. Grouped box plots corresponding to gross national income

I standardized the EPI scores with respect to region and then GNI. I was able to do this by separating countries according to their respective groupings and dividing each country's original EPI score by the group average. This allows all the countries' EPI scores to be evaluated on a similar scale. This obviously altered the EPI scores of many countries and groups which can be seen in Figures 5 and 7.

Conclusion and Future Research

In conclusion, there is clear variation in the EPI scores for countries of different regions and GNI groups. We can see this in the vast differences between the new rankings paired accounting for GNI grouping next to the original EPI rankings. The new top 10 ranked countries are displayed below.

Country	GNI Adjusted Rank	Original Rank
Romania	1	32
Ukraine	2	60
Iran	3	67
Tunisia	4	71
Denmark	5	1
Luxembourg	6	2
Bolivia	7	88
Uzbekistan	8	89
Bulgaria	9	41
Switzerland	10	3

Figure 8. New top 10 ranked countries after adjusting for GNI

In future research, it would be interesting to explore the impact of specific indicators. In my research, I acknowledged the weight that the indicators have on the final EPI score but did not explore those individual measures and how they more specifically vary between regions or GNI groups.

References

- Wendling, Z. A., Emerson, J. W., de Sherbinin, A., Esty, D. C., et al. (2020). 2020 Environmental Performance Index. New Haven, CT: Yale Center for Environmental Law & Policy. epi.yale.edu
- The World Bank. (2022). World Bank Country and Lending Groups [Data file]. Retrieved from <https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups>

Acknowledgments

I would like to express my appreciation to Dr. Debra Hydorn for her support and guidance throughout the entirety of this project.