I. Introduction

The relationship between university rankings and various socioeconomic factors is a topic of great interest in the field of higher education. By examining the findings from Spearman correlation coefficients across multiple ranking systems, we can gain insights into the associations between university rankings, GDP (Gross Domestic Product), and population rank. This analysis aims to shed light on the relationships between these factors and provide a deeper understanding of the complex dynamics that influence university rankings. Understanding these associations can help policymakers, educators, and stakeholders in the higher education sector make informed decisions and develop strategies to enhance academic excellence and support the growth of universities.

II. Methodology

Data on university rankings, GDP, and population rank was obtained from *Kaggle*. The data was cleaned and standardized using *Pandas* and *NumPy*, removing duplicates and handling missing values. The datasets were merged based on common variables to create a unified dataset. Spearman correlation coefficients were then calculated using *Pandas* and *NumPy* to analyze the relationships between university rankings, GDP, and population rank. *Matplotlib* and *Seaborn* were used to create the heatmap and scatterplots of the correlations. Spearman correlation was chosen over Pearson correlation because it captures both linear and nonlinear associations, making it more suitable for this analysis.

III. About the Data

The analysis incorporated data from various university ranking bodies from the university ranking dataset to explore the relationships between university rankings, GDP, and population rank. Here's a brief overview of each ranking body:

- **CWUR (Center for World University Rankings).** The CWUR dataset included information on 2,000 universities worldwide, with columns such as World Rank, Institution, Location, National Rank, Quality of Education, Alumni Employment, Quality of Faculty, Research Performance, and Score.
- **GreenMetric.** This dataset consisted of 911 universities and provided information on environmental sustainability and infrastructure, including columns such as University, Country, Total Score, Setting & Infrastructure, Energy & Climate Change, Waste, Water, Transportation, Education & Research, and Rank.

- **Leiden Ranking.** The Leiden dataset encompassed 1,176 universities and included columns such as Rank, Country, University, P, P(Top 50%), and PP(top 50%). It focused on scientific performance based on bibliometric indicators.
- **NatureIndex.** The NatureIndex dataset covered 500 universities and contained columns such as Institution, Country, Share 2019, Share 2020, Count 2020, and Change Adjusted in Share 2019-2020. It assessed scientific research output published in high-quality natural science journals.
- **Times Higher Education.** The Times dataset included 1,397 universities and featured columns such as rank, name, scores for teaching, research, citations, industry income, international outlook, and various statistics on student population and gender ratios.
- **URAP (University Ranking by Academic Performance).** The URAP dataset encompassed 3,000 universities and included columns such as Rank, University, Country, Article, Citation, Total Documents, AIT, CIT, Collaboration, and Total. It focused on academic performance indicators.
- **Webometrics.** This dataset contained information on 11,729 universities and included columns such as Ranking, University, Country, Impact Rank, Openness Rank, and Excellence Rank. It focused on web presence and online visibility of universities.

By incorporating data from these diverse ranking bodies, the analysis aimed to provide comprehensive insights into the relationships between university rankings, GDP, and population rank, shedding light on various aspects of higher education worldwide.

IV. Analysis and Findings

Based on the Spearman correlation coefficients, which measure the strength and direction of the relationship between variables, the following findings can be observed for each ranking system:

CWUR

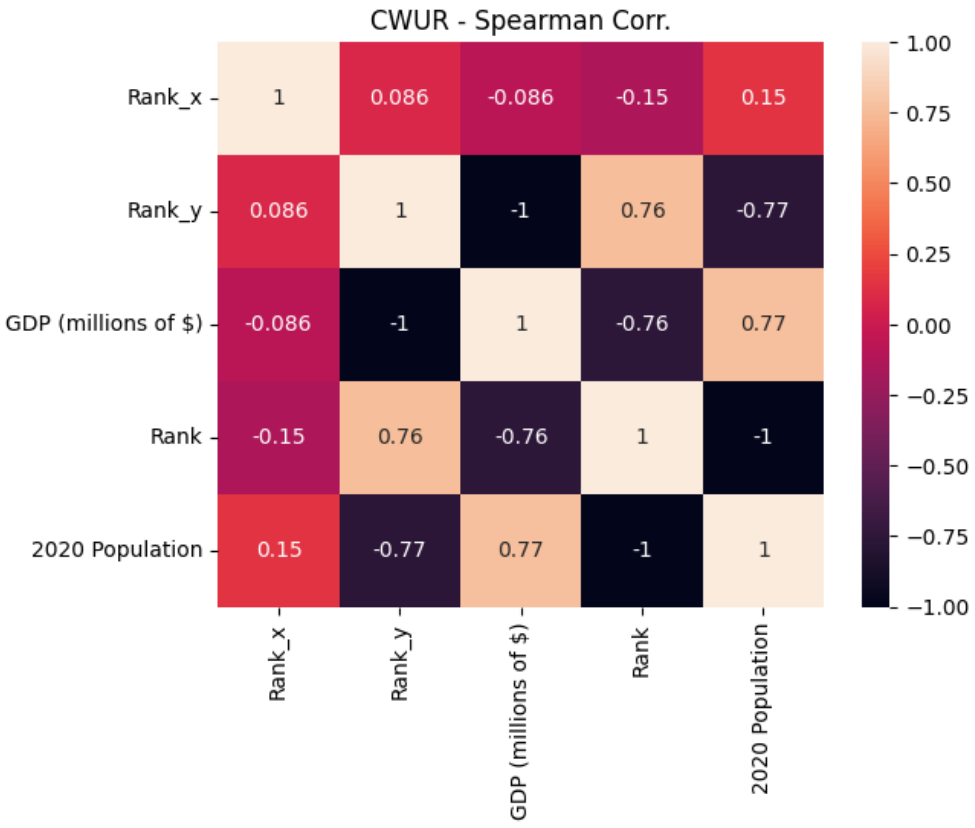

Figure 1. CWUR Correlation Heatmap

University Ranking vs. GDP. The correlation coefficient of 0.08 suggests a weak positive relationship between university rankings and GDP. This implies that there is a slight tendency for countries with higher GDP to have higher-ranked universities, although the relationship is not significant.

University Ranking and Population Rank. With a correlation coefficient of -0.15, there is a weak negative relationship between university rankings and population rank. This indicates that countries with lower population rankings tend to have slightly higher-ranked universities, but the association is not strong.

GDP and Population Rank. The strong positive correlation coefficient of 0.76 indicates a clear and robust relationship between GDP and population rank. Countries with higher GDP tend to have higher population ranks.

GreenMetric

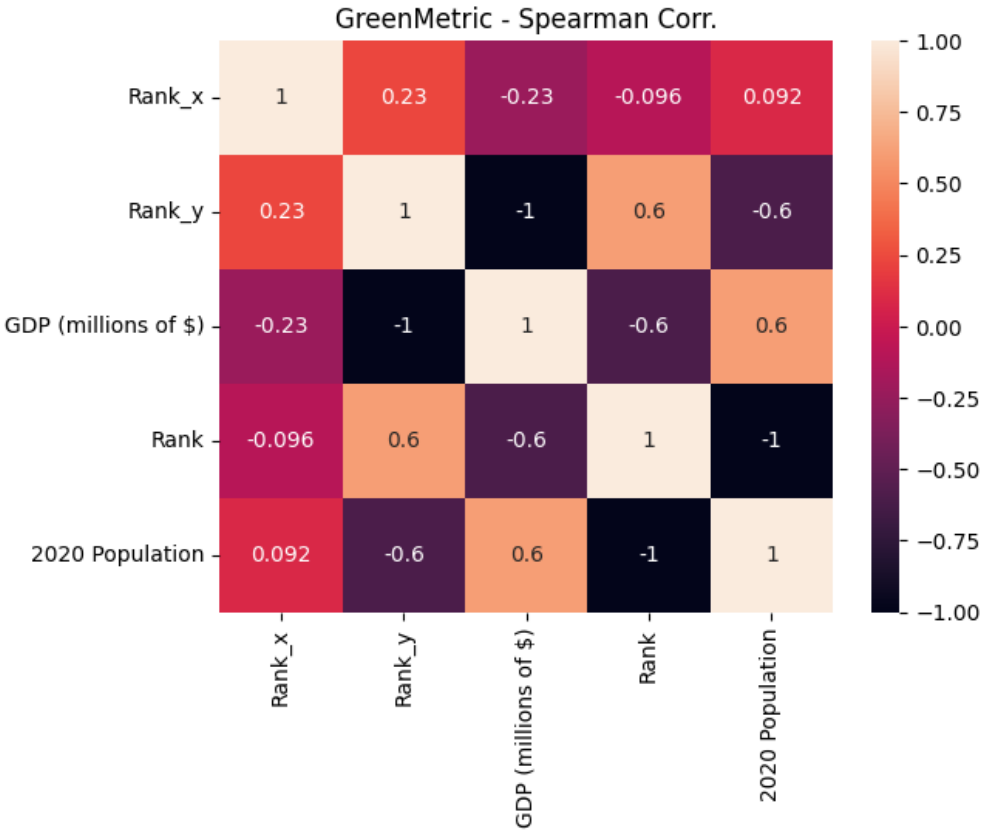

Figure 2. GreenMetric Correlation Heatmap

University Ranking vs. GDP. The correlation coefficient of 0.23 suggests a weak positive relationship between university rankings and GDP. This implies that countries with higher GDP may have slightly higher-ranked universities, but the association is not strong.

University Ranking and Population Rank. The correlation coefficient of -0.096 indicates a weak negative relationship between university rankings and population rank. This suggests that countries with lower population rankings might have slightly higher-ranked universities, although the relationship is not significant.

GDP and Population Rank. With a correlation coefficient of 0.6, there is a strong positive relationship between GDP and population rank. Countries with higher GDP tend to have higher population ranks.

Leiden

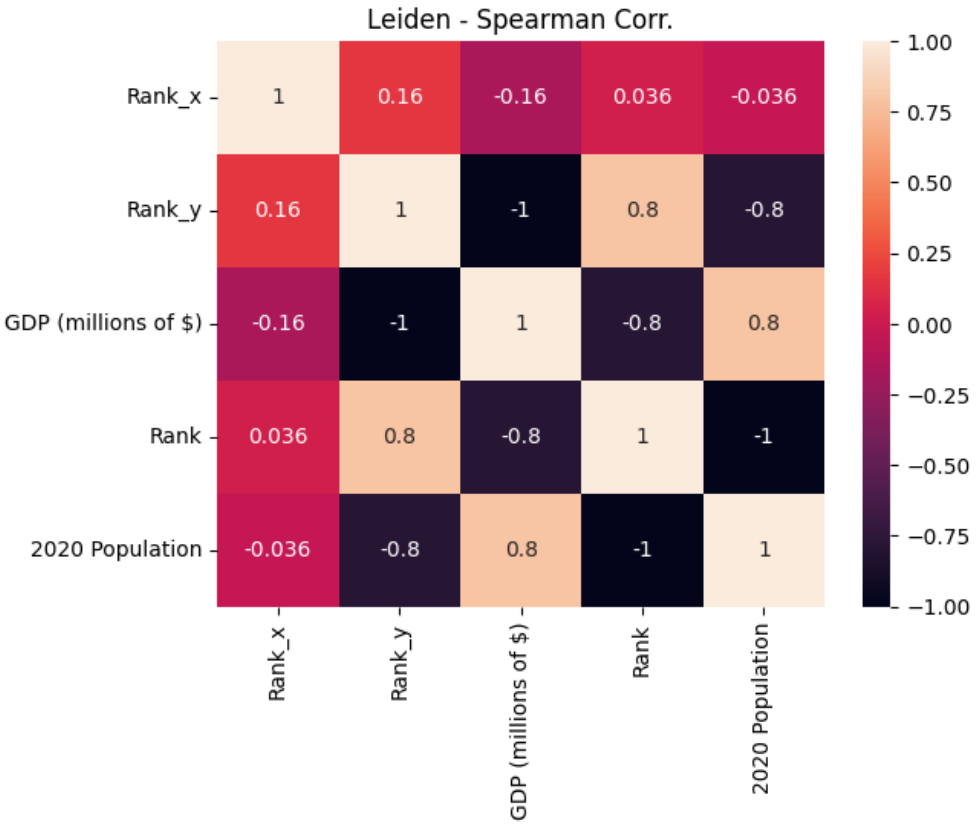

Figure 3. Leiden Correlation Heatmap

University Ranking vs. GDP. The correlation coefficient of 0.16 indicates a weak positive relationship between university rankings and GDP. This suggests that countries with higher GDP may have slightly higher-ranked universities, although the association is not strong.

University Ranking and Population Rank. With a correlation coefficient of 0.036, there is a weak positive relationship between university rankings and population rank. This suggests that countries with higher population ranks might have slightly higher-ranked universities, although the relationship is not significant.

GDP and Population Rank. The strong positive correlation coefficient of 0.8 indicates a clear and robust relationship between GDP and population rank. Countries with higher GDP tend to have higher population ranks.

NatureIndex

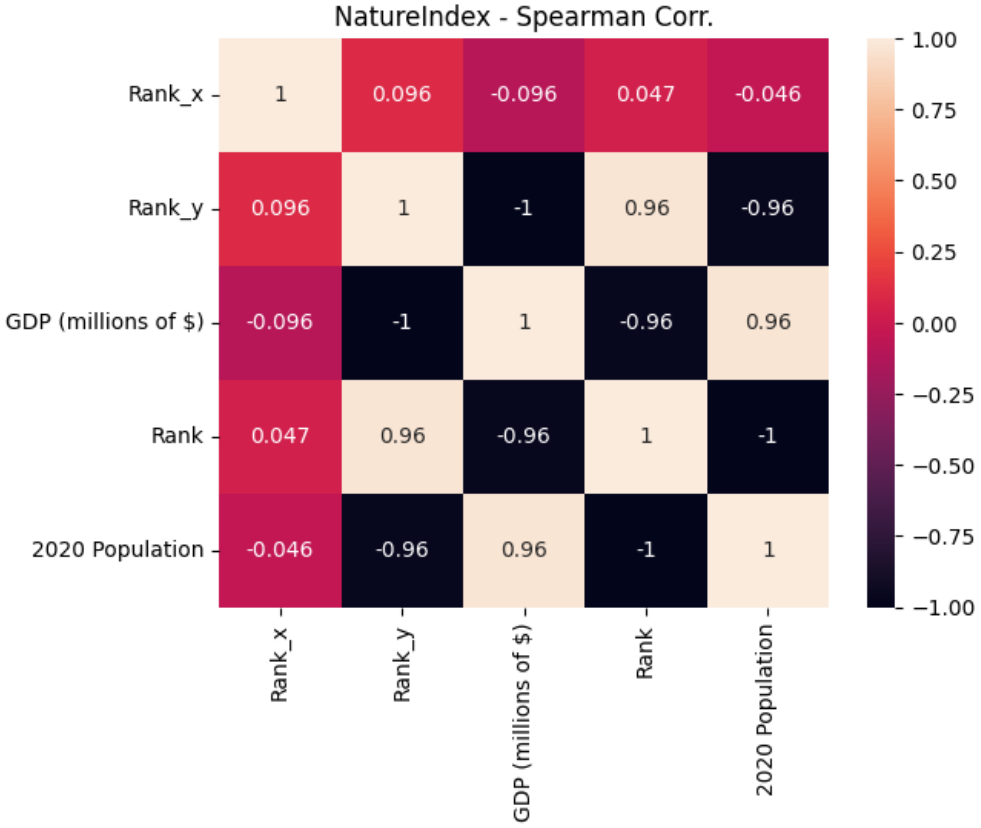

Figure 4. NatureIndex Correlation Heatmap

University Ranking vs. GDP. With a correlation coefficient of 0.096, there is a weak positive relationship between university rankings and GDP. This implies that countries with higher GDP may have slightly higher-ranked universities, although the association is not strong.

University Ranking and Population Rank. The correlation coefficient of 0.047 suggests a weak positive relationship between university rankings and population rank. This implies that countries with higher population ranks might have slightly higher-ranked universities, but the relationship is not significant.

GDP and Population Rank. The strong positive correlation coefficient of 0.96 indicates a clear and robust relationship between GDP and population rank. Countries with higher GDP tend to have higher population ranks.

Times

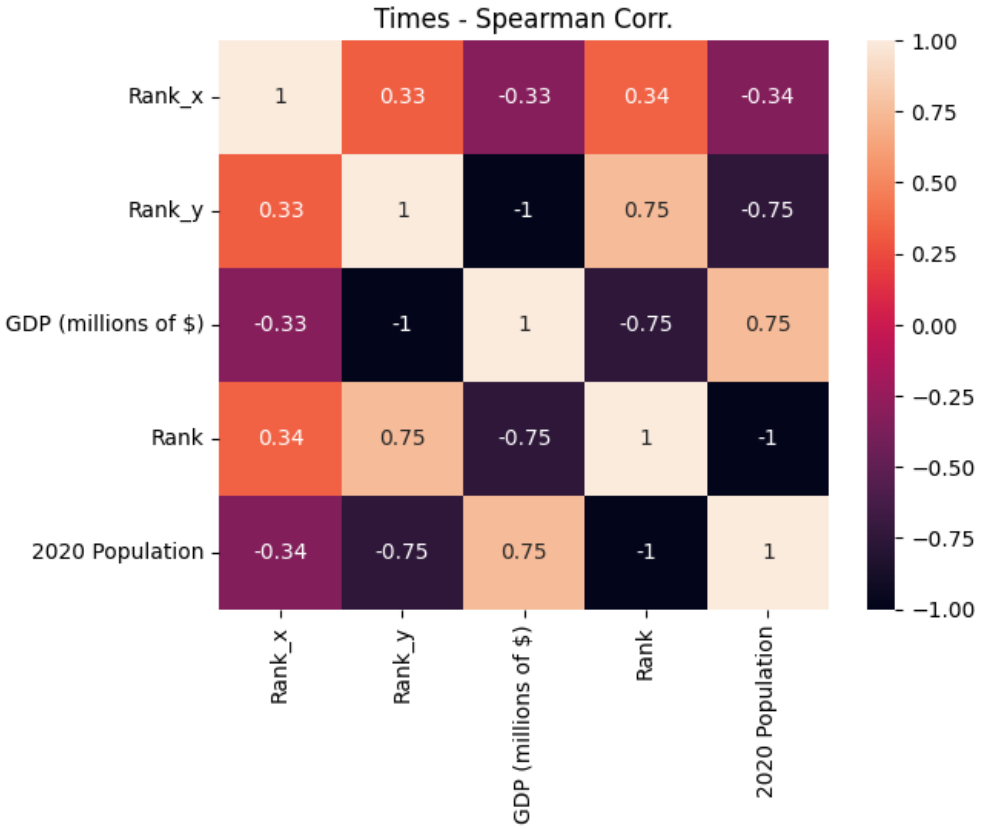

Figure 5. Times Correlation Heatmap

University Ranking vs. GDP. The correlation coefficient of 0.33 suggests a moderate positive relationship between university rankings and GDP. This implies that countries with higher GDP tend to have moderately higher-ranked universities.

University Ranking and Population Rank. With a correlation coefficient of 0.34, there is a moderate positive relationship between university rankings and population rank. This suggests that countries with higher population ranks tend to have moderately higher-ranked universities.

GDP and Population Rank. The correlation coefficient of 0.75 indicates a strong positive relationship between GDP and population rank. Countries with higher GDP tend to have higher population ranks.

URAP

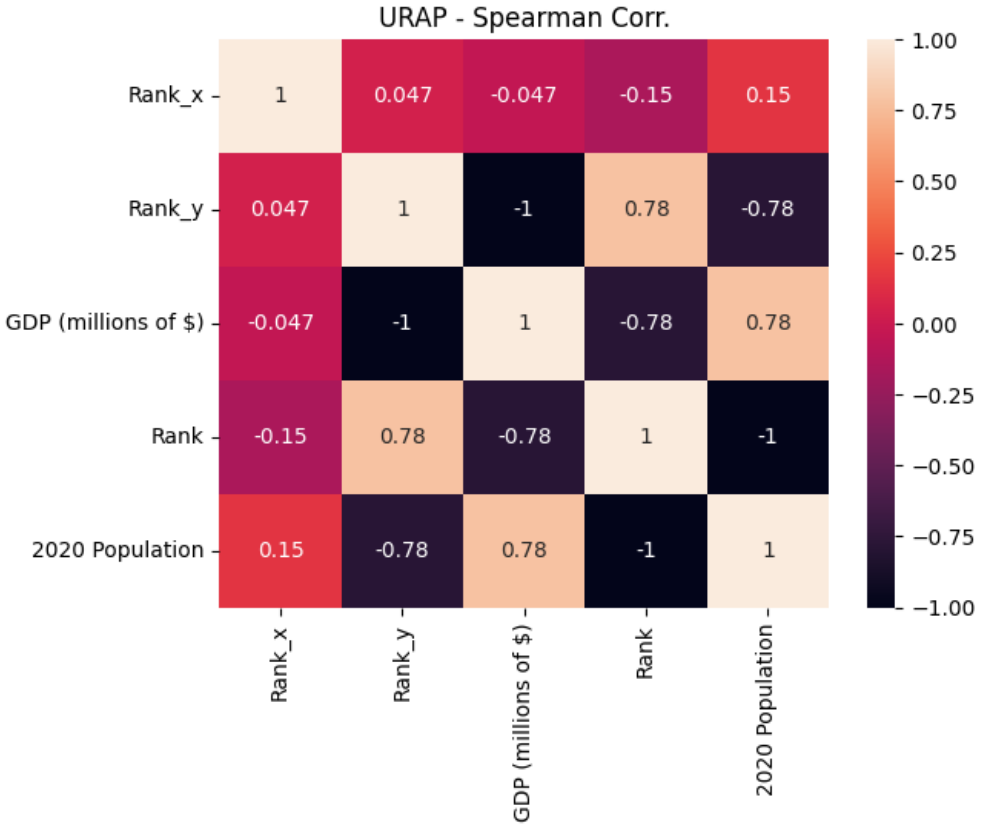

Figure 6. URAP Correlation Heatmap

University Ranking vs. GDP. The correlation coefficient of 0.047 suggests a weak positive relationship between university rankings and GDP. This implies that countries with higher GDP may have slightly higher-ranked universities, although the association is not strong.

University Ranking and Population Rank. With a correlation coefficient of 0.15, there is a weak positive relationship between university rankings and population rank. This suggests that countries with higher population ranks might have slightly higher-ranked universities, but the relationship is not significant.

GDP and Population Rank. The strong positive correlation coefficient of 0.78 indicates a clear and robust relationship between GDP and population rank. Countries with higher GDP tend to have higher population ranks.

Webometrics

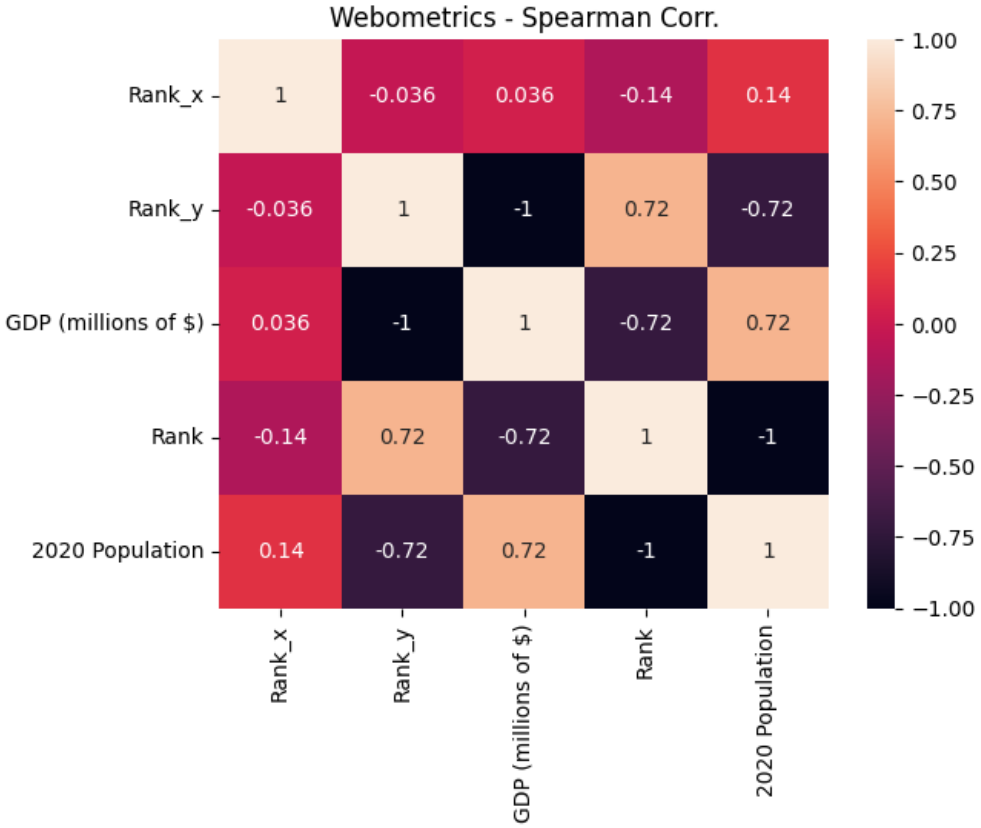

Figure 7. Webometrics Correlation Heatmap

University Ranking vs. GDP. With a correlation coefficient of -0.036, there is a weak negative relationship between university rankings and GDP. This implies that countries with higher GDP may have slightly lower-ranked universities, although the association is not strong.

University Ranking and Population Rank. The correlation coefficient of -0.14 indicates a weak negative relationship between university rankings and population rank. This suggests that countries with higher population ranks might have slightly lower-ranked universities, but the relationship is not significant.

GDP and Population Rank. The strong positive correlation coefficient of 0.72 indicates a clear and robust relationship between GDP and population rank. Countries with higher GDP tend to have higher population ranks.

V. Implications and Discussion

Countries. The findings have significant implications for countries in terms of their global competitiveness and economic growth. Governments can leverage these insights to formulate policies that prioritize investments in higher education and research, as higher-ranked universities tend to have a positive correlation with GDP. By allocating resources to improve educational infrastructure, research funding, and innovation ecosystems, countries can enhance their university rankings, attract international students and researchers, and stimulate economic development.

Universities. Universities can use these findings to strategically position themselves in the global higher education landscape. Understanding the weak positive relationship between rankings and GDP, universities can focus on developing strong research programs, fostering industry collaborations, and promoting entrepreneurship to enhance their reputation and attract top-tier students and faculty. By aligning their offerings with market demands and emphasizing the quality of education, universities can enhance their competitiveness and improve student outcomes.

Students. For students, the findings emphasize the need to consider a wide range of factors beyond university rankings when choosing educational institutions. While rankings may provide some insights, it is essential for students to focus on their academic and career aspirations, program offerings, faculty expertise, research opportunities, and student support services. By conducting thorough research and exploring diverse options, students can make informed decisions and select universities that best align with their goals and provide them with a high-quality education.

Those Paying Tuitions. Individuals responsible for paying tuition, such as parents or sponsors, can benefit from these insights by considering the value proposition offered by universities. While higher-ranked universities may come with a higher price tag, it is important to assess the overall educational experience, including factors like teaching quality, campus facilities, alumni networks, and job placement rates. By evaluating the return on investment beyond rankings, those paying tuition can make more informed decisions about where to invest their resources.

Employers. The findings have implications for employers seeking to hire graduates from universities. While rankings can be one factor in evaluating the quality of graduates, employers should also consider other aspects such as the relevance of the curriculum, industry partnerships, internships, and the reputation of specific programs within universities. Engaging in partnerships with higher-ranked universities or those with specialized programs can help employers attract talent and collaborate on research and development initiatives.

Individuals Interested in Enrolling. Prospective students interested in enrolling in these universities should consider the implications of these findings on their decision-making process. They can explore universities that offer strong programs in their areas of interest, provide opportunities for personal and professional growth, and have a reputation for academic excellence. By conducting thorough research, visiting campuses, and engaging with current students and alumni, individuals can gain insights into the university's culture and determine if it aligns with their educational and career goals.

VI. Conclusion

Based on the findings from the Spearman correlation coefficients, which measure the strength and direction of the relationships, several patterns can be observed across the different university ranking systems. Firstly, there seems to be a consistent weak positive relationship between university rankings and GDP across most of the ranking systems, indicating that countries with higher GDP tend to have slightly higher-ranked universities. However, this association is not particularly strong, suggesting that other factors beyond economic indicators influence university rankings. Secondly, the relationship between university rankings and population rank is generally weak and inconsistent. While some ranking systems show a weak negative relationship, implying that countries with lower population ranks may have slightly higher-ranked universities, the overall association is not significant. Lastly, there is a clear and robust positive relationship between GDP and population rank, indicating that countries with higher GDP tend to have higher population ranks. Overall, these findings highlight the complex nature of university rankings, which are influenced by a variety of factors beyond just economic and demographic indicators.

VII. Appendix

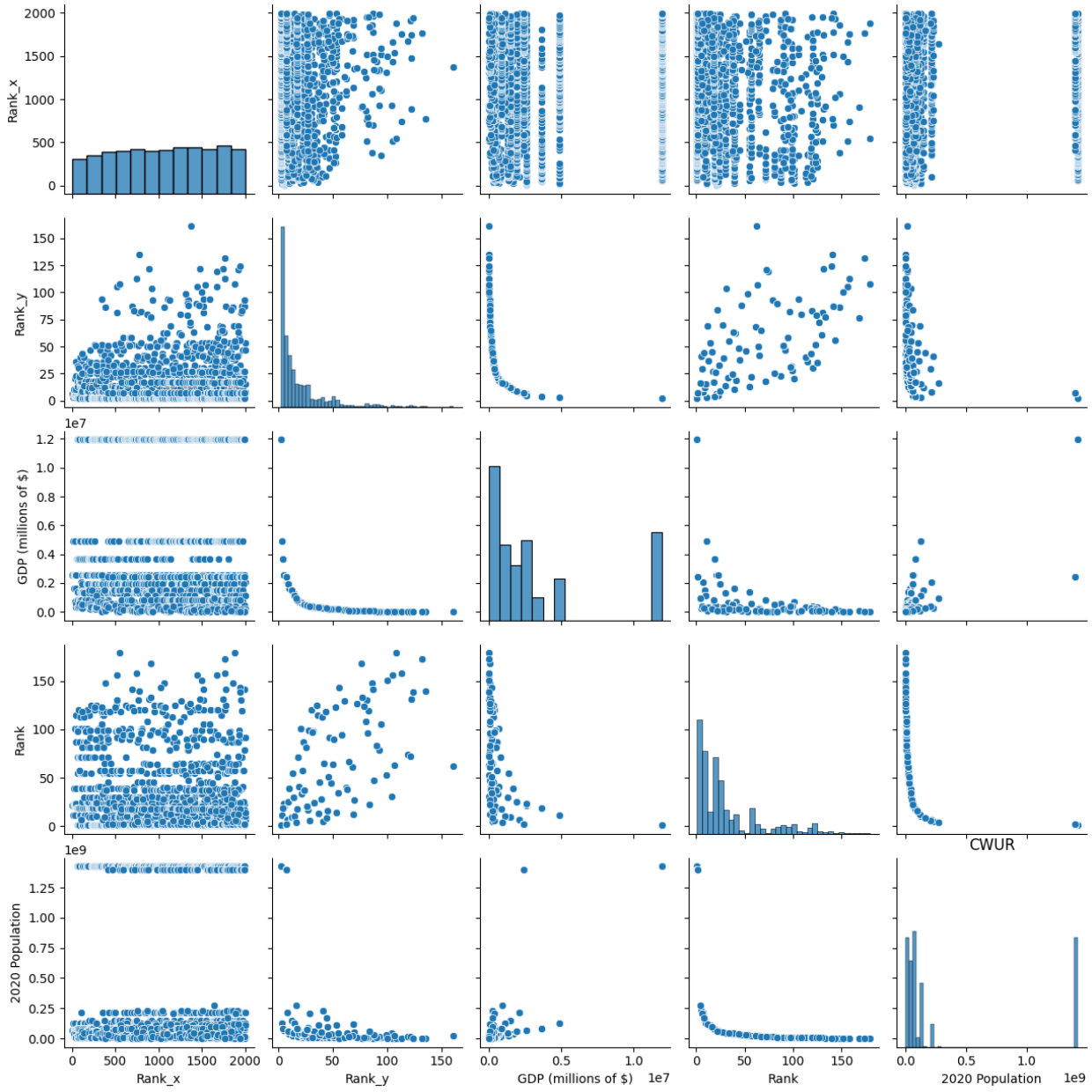

Figure 8. CWUR pairplot

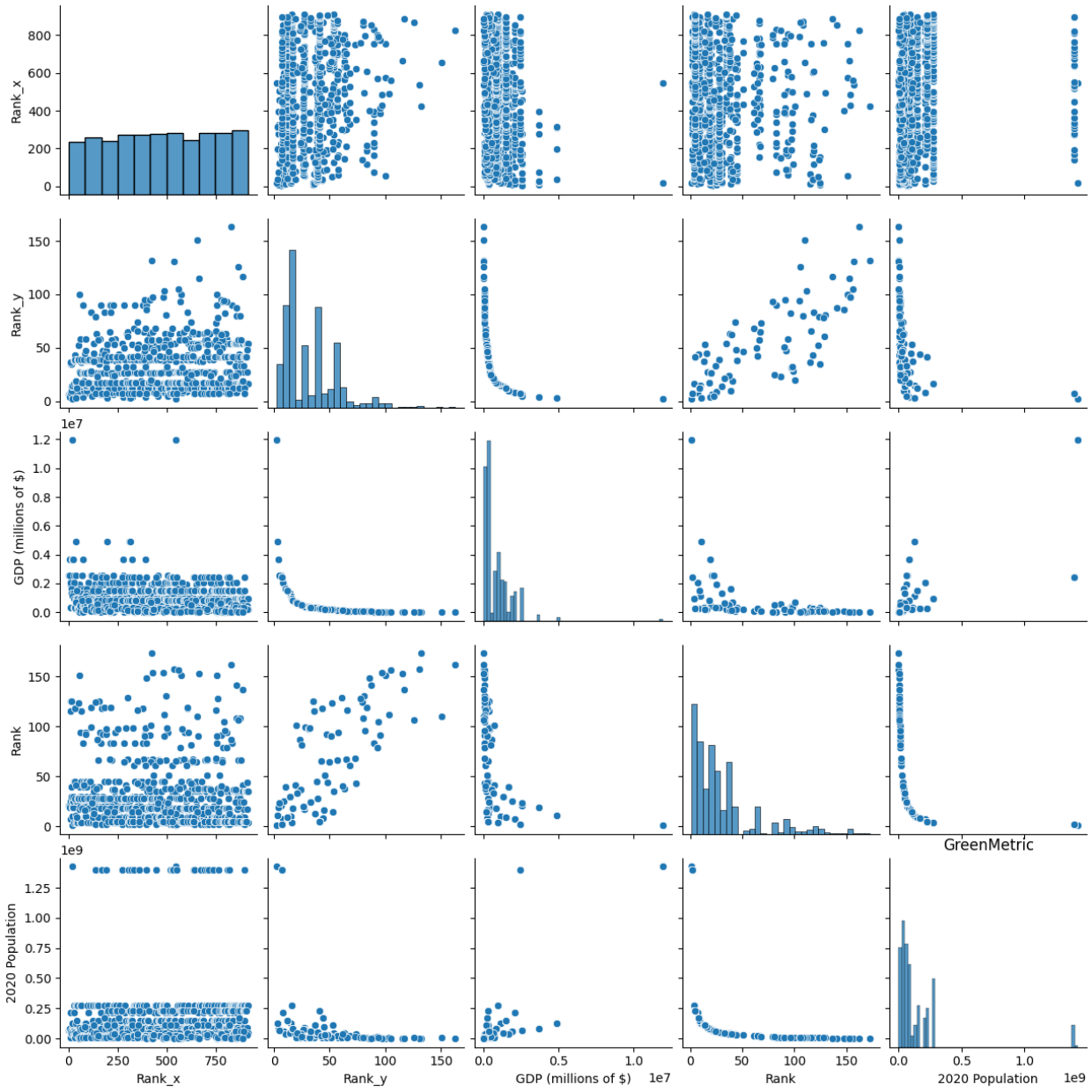

Figure 9. GreenMetric pairplot

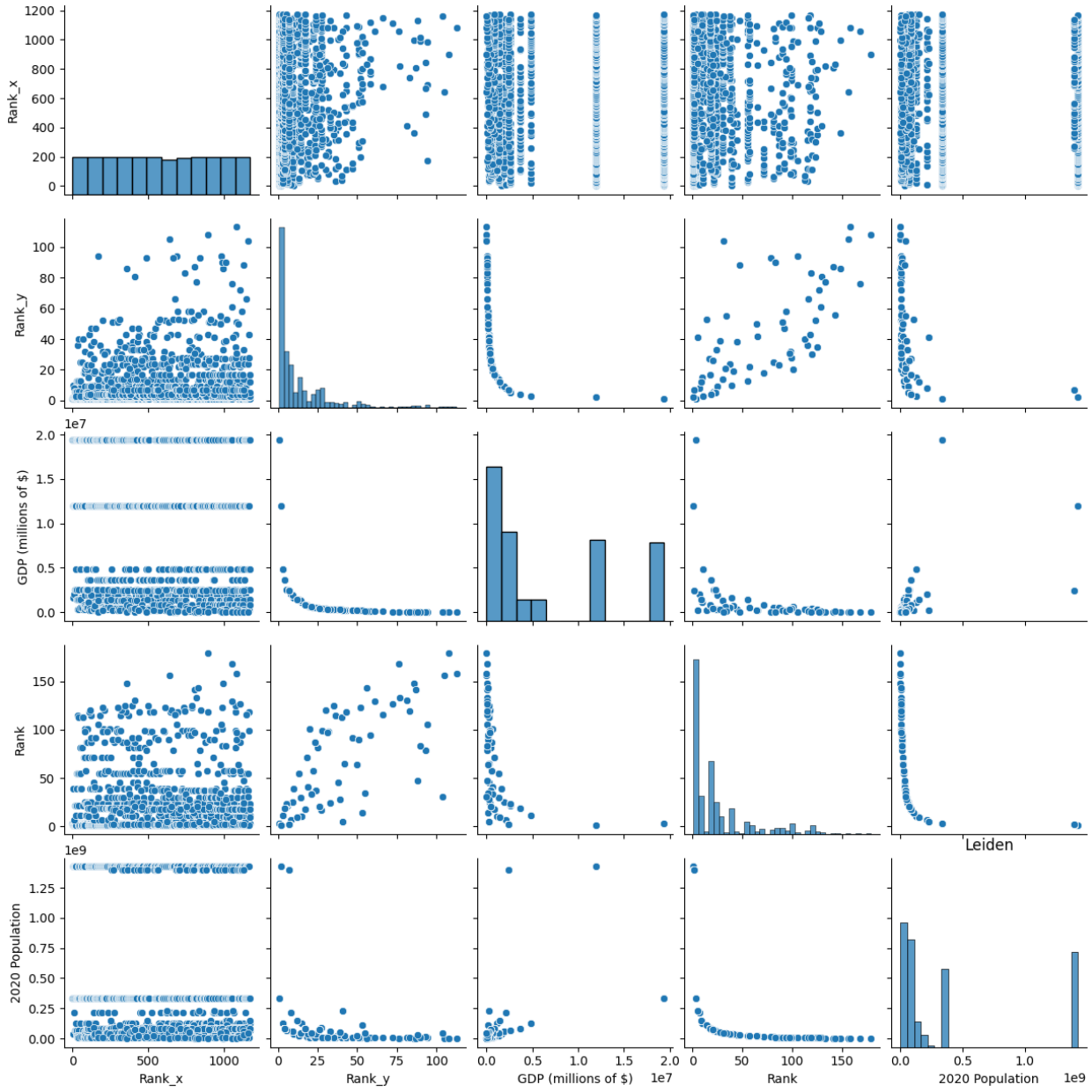

Figure 10. Leiden pairplot

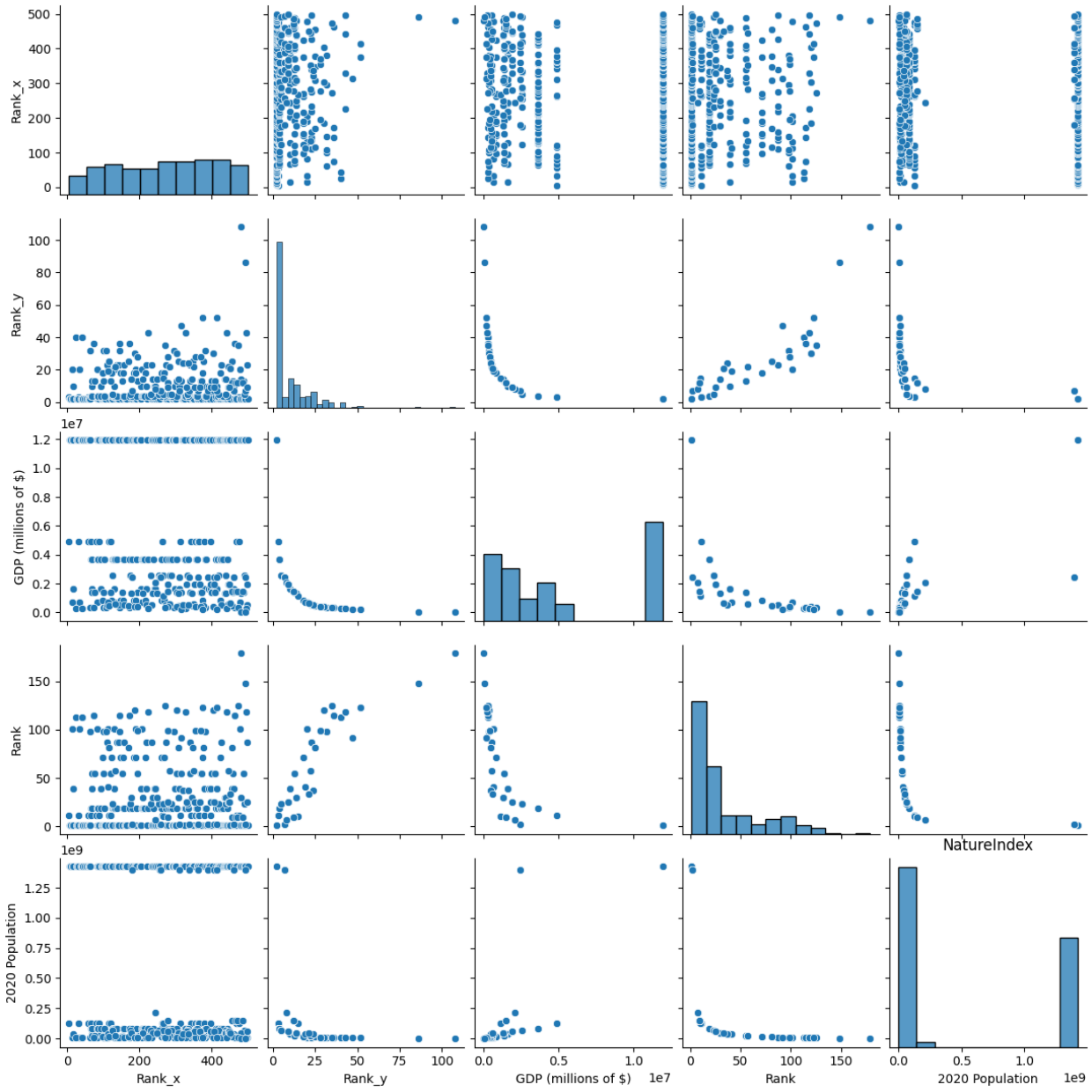

Figure 11. NatureIndex pairplot

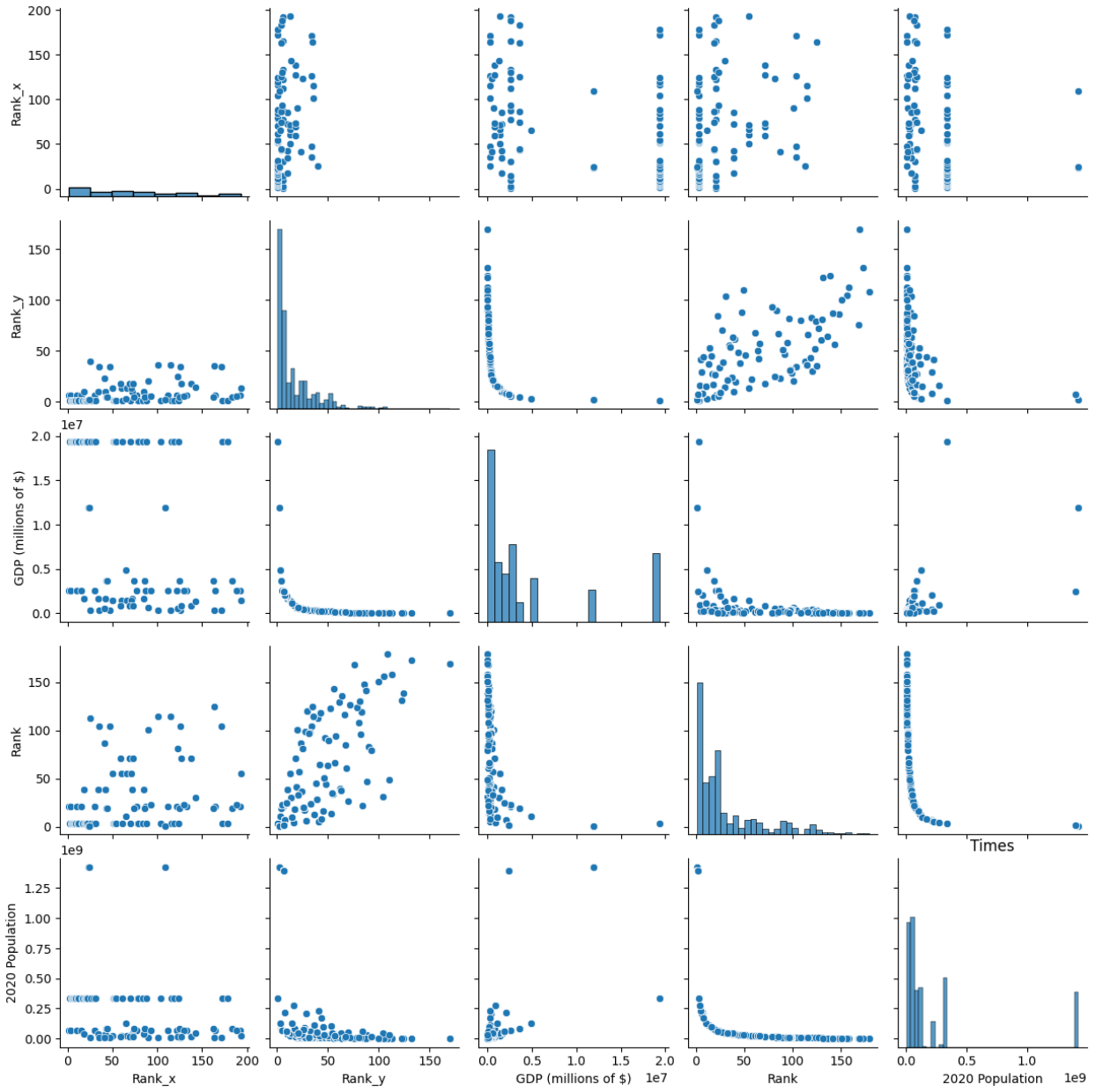

Figure 12. Times pairplot

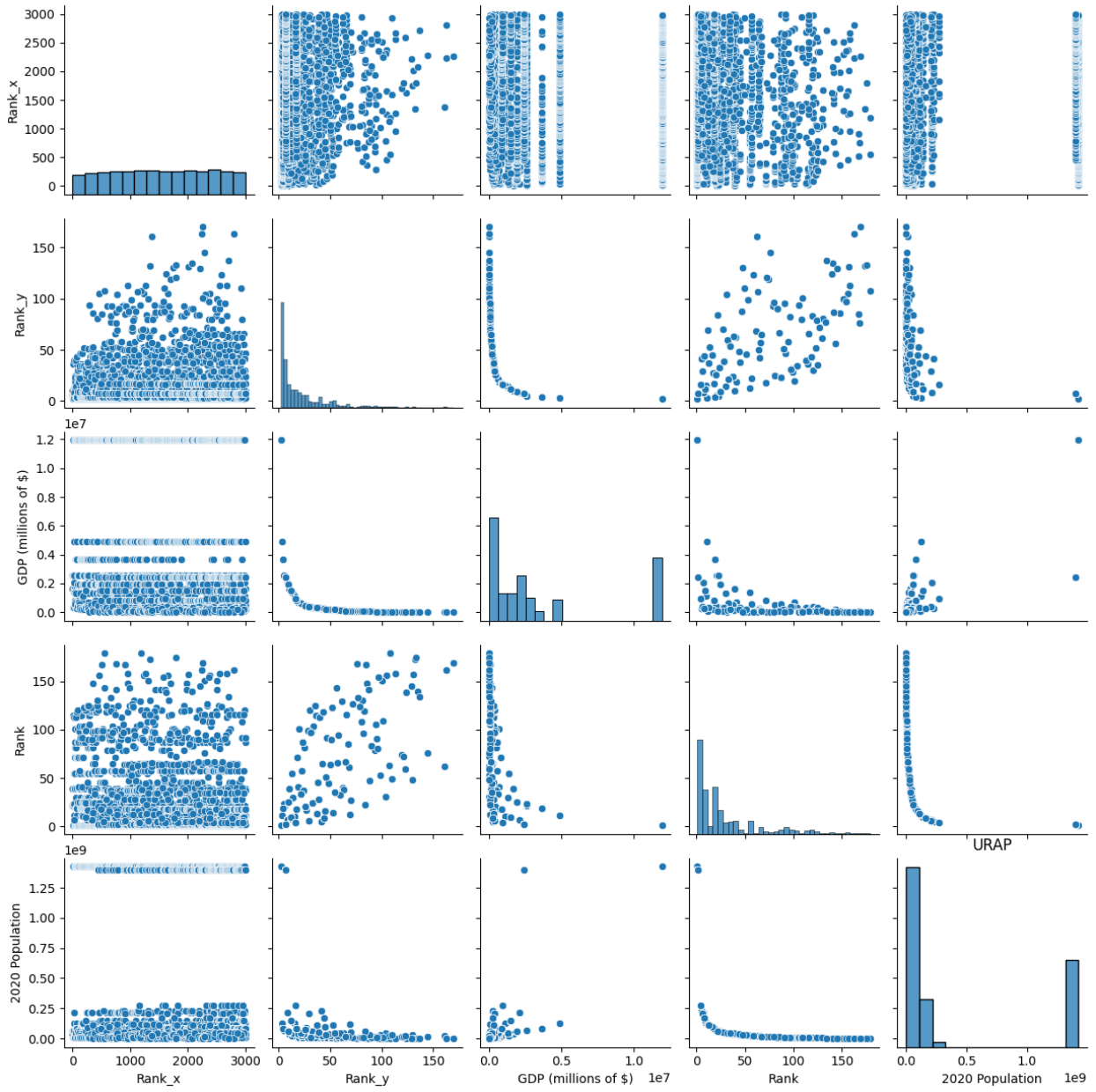

Figure 13. URAP pairplot

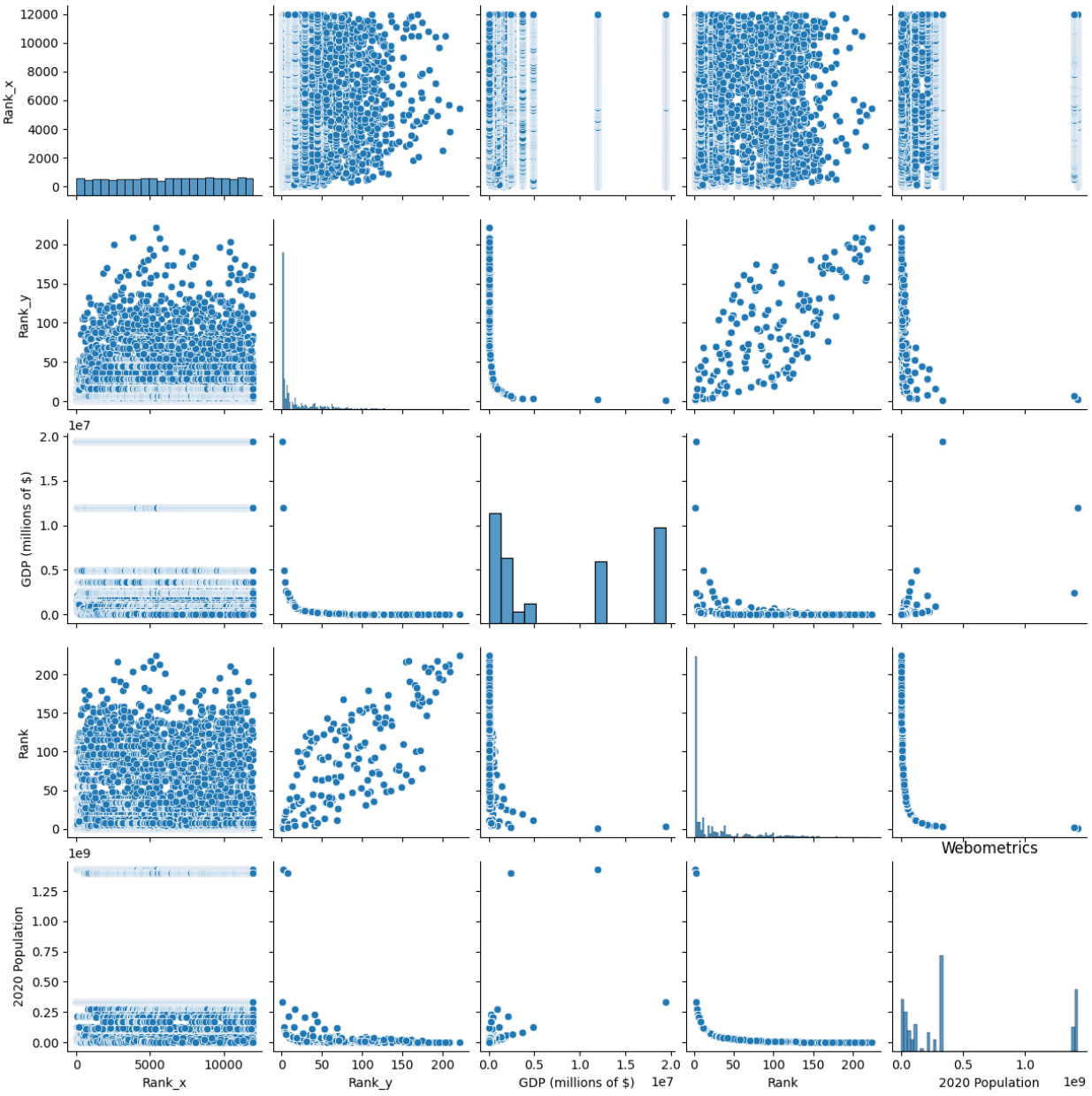

Figure 14. Webometrics pairplot

VIII. References

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