FROM INVESTMENT TO EXCELLENCE? EXPLORING THE RELATIONSHIP BETWEEN R&D SPENDING AND QS TOP 500 UNIVERSITY PRESENCE ACROSS COUNTRIES IN 2022

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Abstract: The main objective of this paper is to examine the relationship between higher education and a country's socio-economic development by analysing national investment in research and development as a share of GDP and its association with higher education quality, as reflected in global university rankings.
The relationship between research investment and university rankings has been explored, with numerous studies underscoring the pivotal role of research and development (R&D) funding in shaping academic and institutional performance. Van Vught, F., & Ziegele, F. in 2013 criticized the existing university rankings for focusing too narrowly on research, leading to a negative effect on the diversity of higher education institutions. As Hazelkorn concluded in 2009, by using a particular set of metrics to highlight research as the key proxy for higher education quality and excellence, rankings are helping to reshape higher education and reconstruct our understanding of what is research/knowledge production and who/which institutions should contribute. In international contexts, disparities in R&D investment have significant implications for university rankings. Farrell et al. (2006) observed that the EU lags the US and Japan in R&D expenditure as a percentage of GDP, while Cimini, Zaccaria, and Gabrielli (2016) noted that developed nations, despite financial crises, have generally increased R&D investments, leading to improved scientific performance.
The literature demonstrates a strong correlation between research investment and university rankings. While increased funding supports research output and institutional reputation, ranking systems are widely criticized for overemphasizing research performance and being controlled by private, for-profit entities. Given this emphasis, higher national investment in research and development is assumed to enhance universities' research output and, consequently, their position in global rankings, despite persistent structural biases and inequalities within ranking methodologies.
Pearson's correlation analysis was used to examine the relationship between the number of QS Top 500 universities and national investment in research and development (R&D). The results show a statistically significant moderate positive correlation at the 0.01 level (two-tailed), indicating that countries with a higher number of top-ranked universities tend to allocate a larger share of their GDP to R&D. While the relationship is not strong, it is meaningful and unlikely to have occurred by chance, supporting the hypothesis of a positive association between research investment and global university standing. These findings align with existing literature, which highlights the role of research funding in strengthening academic output and institutional reputation, while also acknowledging persistent systemic limitations such as disciplinary bias, linguistic barriers, and unequal resource distribution. Overall, the results underscore the importance of sustained research investment in shaping both national innovation capacity and global academic competitiveness.
Keywords: changes, management, principles, steps

1. INTRODUCTION

The importance of the Research and Development (R&D) activities for economic growth has been formally recognized by the European Union (EU) in the Lisbon Agenda (2000) (Farrell, Harmon, Laffan, and O'Carroll, 2006). Putting money into research and development (R&D) is strongly linked to economic growth. The US, Germany, and South Korea are some of the countries that spend a lot of money on research and development (R&D). These countries are always the first to receive new technology, and their businesses are very productive (OECD, 2023). The World Bank estimated in 2022 that if R&D spending goes up by 1%, GDP growth might go up by 0.61%. Another important way to estimate a country's economic strength and ability to come up with new ideas is to look at the percentage of its GDP that goes to research and development (European University Association, 2024). The spillover effects of university R&D expenditures on local economies were emphasized, as higher R&D spending correlated with increased firm formation and economic growth. According to the World Bank (2022), governments, businesses, and universities need to keep making research investment a top priority if they wish to solve global problems and promote long-term development. The amount of GDP that goes to research and development is still a useful way to keep an eye on growth in both science and the economy.

Guerrero et al. (2015) and Marozau et al. (2016) emphasized the interdependence between tertiary education and economic performance, particularly in high-technology industries where universities act as critical sources of R&D-based growth. Similarly, Meo, Al Masri, Usmani, and Memon (2013) found that R&D spending positively correlates with research outputs, including published documents and H-index, reinforcing the significance of investment in fostering academic excellence. The relationship between research investment and university rankings, as a measurement for quality of higher education, has been explored, with numerous studies underscoring the pivotal role of research and development (R&D) funding in shaping academic and institutional performance. Farrell et al. (2006) observed that the EU lags behind the US and Japan in R&D expenditure as a percentage of GDP, while Cimini, Zaccaria, and Gabrielli (2016) noted that developed nations, despite financial crises, have generally increased R&D investments, leading to improved scientific performance. Pan et al. (2012) further emphasized the necessity of exceeding certain funding thresholds to achieve impactful outcomes. Universities aim to provide quality education to its students. Quality assessment has become one of the most prominent issues in discussions about higher education, both within the academic world and in higher education policy (Federkeil, 2008). The notion of quality in higher education is wide (Cadena, Luis García, Loza-Aguirre, Ortiz, Pérez and Segura-Morales, 2018). A superior quality of higher education ensures the upcoming workforce attains the necessary qualifications to propel the nation towards elevated levels of development (Vasilevska and Tomovska – Misoska, 2024). Quality Assurance (QA) is at the top of most universities' agendas, and quality evaluation and enhancement are without any doubt among most important tasks of any higher education institution all around the world (Costreie, Ianole and Dinescu, 2022). However, the current understanding of this problematic varies not only from country to country, but from university to university. Success of a higher education establishment can be measured by different metrics, like by the academic results of the admitted students, by the employment characteristics of graduates, by the participation of industry, or by the research output. In the case of universities, there are several metrics enabling qualitative assessment, including the oversubscribed proportion of the admissions, the admission score, the proportion of international students, the ratio of students to lecturers, the number of lecturers with PhDs, etc. (Szluka, Csajbók and Győrfy, 2023). European University Association shared a conclusion that there is no single definition of quality for university activities. According to them success must be considered in the context of national, institutional, and departmental or subject-specific parameters (EUA, 2023). The measurement of the quality assurance can be detected to two parallel systems, the accreditation process and the university rankings. The first one-the accreditation is a process where indicators and standards are settled by external agencies and/or national bodies. This includes monitoring and evaluation of teaching and learning and research capacities of the higher education institutions. The second system- the university rankings are widely regarded as tools for assessing the quality of higher education institutions, influencing perceptions among students, policymakers, and institutional leaders (Hazelkorn, 2015). They serve as external benchmarks, often reflecting and shaping views on academic excellence and institutional reputation (Shin, Toutkoushian and Teichler, 2011). University rankings represent a widely used and accessible tool for evaluating higher education performance (Nassa & Arora, 2021). However, the relationship between rankings and actual academic quality is complex and contested. While rankings highlight performance indicators such as research output, faculty credentials, and internationalization, they may not capture the full scope of educational quality, such as teaching effectiveness or student support services (Salmi & Saroyan, 2007). Critics argue that the growing influence of rankings can lead institutions to prioritize metrics that improve rank rather than invest in meaningful quality improvements (Hazelkorn, 2015; Dill and Soo, 2005). Therefore, although rankings offer valuable insights, they should be interpreted cautiously and supplemented with other qualitative assessments to form a comprehensive view of an institution's quality.

The main objective of this paper is to examine the relationship between the quality of higher education and a country's socio-economic development by analysing national investment in research and development (R&D) as a share of GDP and its association with higher education quality, as reflected in global university rankings. The study is based on the hypothesis that countries with higher-quality higher education systems invest more in research and development, which in turn contributes to stronger socio-economic development.

The study is examining the relationship between the number of QS Top 500 universities and national investment in research and development (R&D) in 2022 to test whether countries with higher investments in R&D will have better higher education which will lead to greater socio-economic development.

2. MATERIALS AND METHODS

This paper examines the relationship between the quality of higher education and socio-economic development, with the aim of demonstrating how stronger higher education systems contribute to national progress. For the purposes of this paper, the QS World University Rankings were selected as the primary indicator of higher education quality. Quacquarelli Symonds (QS) represents the world's largest global higher education network, connecting universities,

business schools and students. QS develops and successfully implements methods of comparative data collection and analysis used to highlight institutions' strengths. Conducting its first industry-leading research in 1990 when it commissioned a global survey of MBA employers, the QS World University Rankings launched in 2004 in cooperation with Times Higher Education before they separated in 2009 (Baty, 2014) and is now the most established research project operated by the company. THES-QS was designed to take a broader look at the worldclass university: looking at research performance as the Shanghai rankings did but also adding indicators that were supposed to capture something of the 'teaching capacity' as well as the international outlook of an institution. The QS World University Rankings employ a standardized and well-established methodology based on six weighted indicators: (1) Academic Reputation (40%), measured through a global academic survey; (2) Employer Reputation (10%), based on employer assessments of graduate quality; (3) Faculty-to-Student Ratio (20%), reflecting teaching capacity; (4) Citations per Faculty (20%), measuring research impact; (5) International Faculty Ratio (5%); and (6) International Student Ratio (5%) (Ahmad, 2025).

This study relies on secondary data derived from the QS World University Rankings 2022, complemented by socio-economic data from the same year to ensure temporal consistency across variables. The initial phase involved data extraction and organization in Excel, where a basic comparative review of values was performed to identify overarching trends and observable patterns. Filtering in Excel was applied to display the list of countries in descending order, starting from those with the highest number of universities ranked among the QS Top 500 to those with the fewest. The countries with up to 10 institutions among the QS Top 500 are United States of America (83), United Kingdom (46), Germany (29), China (28), Australia (24), Canada (17) Russia (17), South Korea (17), Japan (15), France (13), Italy (13), Netherlands (13), Spain (12), Taiwan (10) and others with below than 10 universities. The figures below present the countries with up to 10 institutions among the QS Top 500 percentage of GDP allocated to Research and Development (R&D). This serves as a preliminary overview of how the quality of higher education is reflected in socio-economic development.

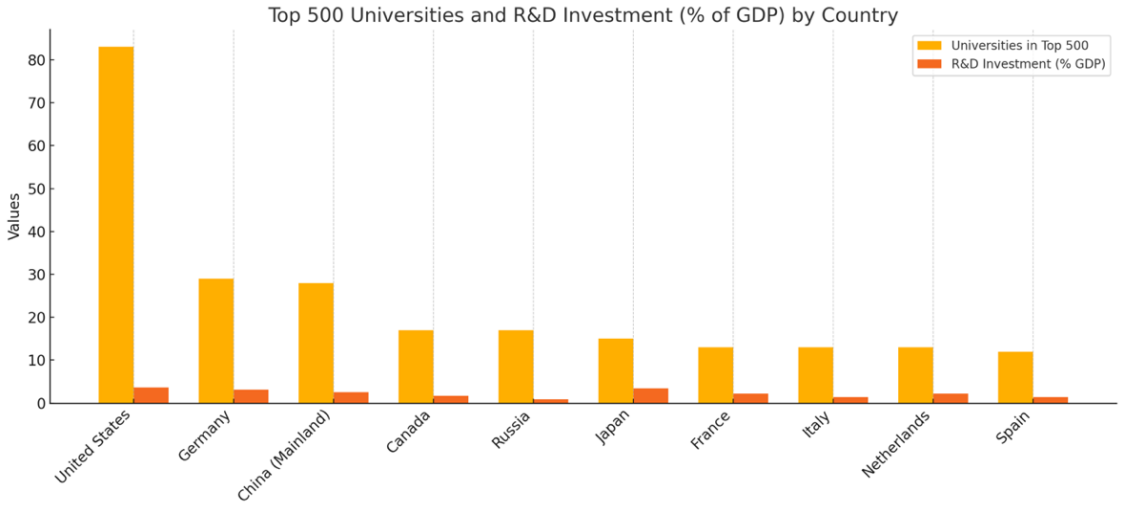
The analytical process began with extracting the list of the top 500 universities for 2022 from the QS World University Rankings database. Using Microsoft Excel, universities were grouped by country to calculate the number of institutions per country represented in the top 500. For countries with at least one ranked institution, additional national-level data were collected to examine correlations between the number of top-ranked universities and selected socio-economic indicators. The study begins with a preliminary analysis of the relationship between the presence of universities in the QS Top 500 and the national expenditure on research and development (R&D) as a percentage of GDP. In specific, a structured quantitative analysis was conducted using SPSS (IBM Statistical Package for the Social Sciences) to assess the extent to which higher education quality aligns with socio-economic development indicators. Descriptive statistics were used to summarize the dataset, while Pearson's correlation coefficient was applied to examine the strength and direction of linear relationships between continuous variables. Variables containing negative values were initially transformed to ensure positivity, and additional logarithmic transformations were applied to normalize distributions and meet the assumptions required for parametric testing.

Data on national investment in research and development, measured as a percentage of GDP for 2022, were obtained from the World Bank DataBank and integrated into the SPSS analysis.

3. RESULTS

Based on the percentage of GDP that each country spends on research and development (R&D), Figure 1 presents countries that have institutions ranked among the QS Top 500. The US, Japan, and Germany stand out because they spend a lot of money on research and development (more than 3% of their GDP). This fits with the fact that they are highly rated in university rankings around the world. A lot of money spent on research and development is also strongly linked to a significant university presence in China. On the other side, Russia, Italy, and Spain spend a lot less on research and development (less than 1.5%), which could make it tougher for them to make advances in science and higher education. This comparison indicates that when more money is given to research and development (R&D), more people around the world often go to college. This highlights how crucial it is for colleges and universities to get money for research.

Figure 1: Countries with up to 10 institutions among the QS Top 500 per country and the % of GDP invested in research and innovation



Lastly, this analysis reveals that rankings don't explain how and to what extent countries that are ranked higher have greater economic and social growth. There is a connection between higher education and how well a country does in things like R&D and innovation, but it's not always a straight line. The evidence reveals that the QS World University Rankings don't reflect how greater higher education helps the economy and society thrive.

The Pearson correlation was also used to explore the relationship between the QS top 500 ranked universities and the investment in research and development (R&D) in their countries. This analysis leads to conclusion that the correlation is statistically significant at the 0.01 level (two-tailed), indicating that the relationship is unlikely to have occurred by chance. The moderate r-value suggests that countries with a greater number of top-ranked universities tend to allocate a higher percentage of their GDP to research and development, highlighting a meaningful connection between the quality of higher education and national commitment to innovation and scientific progress. Even though the link isn't strong, it shows that investing in research infrastructure may help promote academic success, or the other way around. But there are probably other things outside R&D spending that affect how well higher education institutions are known and how well they do around the world. Having this in mind the hypothesis is supported, as the analysis revealed a statistically significant moderate positive correlation, indicating that countries with a higher number of top-ranked universities tend to invest a greater share of their GDP in research and development activities.

Table 1 Results from the correlation between the number of universities ranked among the QS top 500 and the percentage of GDP invested in research and development (R&D).

	Correlations	**R&D Investment**
Number of universities ranked among the QS top 500 in 2022	Pearson Correlation	.35
	Sig. (2-tailed)	0,01
	N	60

The results indicate that countries with a higher number of top-ranked universities generally invest a greater proportion of their GDP in research and development, demonstrating a meaningful link between higher education quality and national commitment to innovation and scientific advancement. This aligns with the broader literature, which consistently shows that research investment strengthens academic output and institutional reputation, although systemic challenges—such as discipline bias, language barriers, and unequal resource allocation—continue to limit inclusivity and impact. While the correlation is moderate and statistically significant, it does not imply direct causation; instead, it suggests a mutually reinforcing relationship where strong R&D ecosystems foster academic excellence, and leading universities, in turn, drive further innovation and competitiveness. These findings support the hypothesis and underline the importance of sustained research funding in shaping both national development and global academic standing.

4. DISCUSSIONS

The analysis revealed a statistically significant moderate positive correlation between the number of universities ranked among the QS Top 500 and national investment in research and development (R&D) as a percentage of GDP. This indicates that countries with a higher concentration of top-ranked universities tend to allocate a larger share of their GDP to R&D activities. The finding aligns with the logic that research funding supports institutional performance in global rankings, given that ranking methodologies place strong emphasis on research output and impact. However, while the correlation is significant, it does not imply direct causation. Increased national R&D spending does not necessarily translate into proportional funding for universities, nor does the presence of top-ranked institutions automatically drive higher national R&D expenditure. Instead, both variables may reflect the strength of broader research ecosystems, policy frameworks, and national priorities that shape innovation capacity. This result underscores the close but complex relationship between research funding, academic prestige, and national innovation. It suggests that while investment in research infrastructure can enhance university performance, systemic factors—such as equitable funding distribution, discipline balance, linguistic inclusion, and governance efficiency—also play critical roles. These findings are in line with the big criticism of the rankings and their connection with the research. Higher education has increasingly evolved into a market-driven and globally competitive sector, with university rankings playing a central role in shaping institutional strategies, funding priorities, and perceptions of quality (Bagley & Portnoi, 2014; Baumann, 2017; OECD, 2025). Originally designed to inform student choice, rankings such as QS, THE, and ARWU have become powerful governance tools, reinforcing competition and prestige-oriented behavior as international students act as global consumers (Fischer, 2013; Larson, 2013). However, rankings systematically privilege large, research-intensive, English-speaking institutions, thereby reproducing social, economic, and geopolitical inequalities (Taylor et al., 2014; Marginson, 2017). Their heavy reliance on bibliometric indicators marginalizes teaching quality, inclusiveness, social impact, and regional engagement, promoting a narrow and market-oriented definition of excellence (Federkeil, 2008; Marginson, 2011). Methodological opacity limited institutional coverage, and weak links between rankings and socio-economic development further undermine their validity as comprehensive measures of higher education quality (Hazelkorn, 2011; EU, 2023). Despite sustained criticism and reform initiatives, rankings continue to exert significant influence on institutional behavior and policy decisions worldwide (Hazelkorn, 2007). These findings reinforce the need for more transparent, multidimensional, and context-sensitive evaluation frameworks that better reflect the diverse missions of higher education institutions and their contributions to equitable socio-economic development.

The findings support the hypothesis/research question that greater national investment in R&D contributes to the presence of more globally ranked universities, reinforcing the link between the quality of higher education and national commitment to scientific and technological progress.

5. CONCLUSIONS

This study confirms the existence of a statistically significant, moderate positive relationship between national investment in research and development (R&D) and the presence of universities ranked among the QS Top 500 in 2022. Countries that allocate a higher share of GDP to R&D tend to host a greater number of globally ranked universities, underscoring the importance of sustained research funding for academic performance and international visibility. These findings align with existing literature that identifies R&D investment as a key driver of innovation, research output, and institutional reputation.

However, the results also demonstrate that the relationship between higher education quality, R&D investment, and socio-economic development is not linear nor deterministic. While research funding supports academic excellence, rankings do not fully capture the broader contributions of higher education institutions to economic growth, social development, teaching quality, or regional engagement. The moderate strength of the correlation suggests a mutually reinforcing relationship rather than direct causation, shaped by wider research ecosystems, policy priorities, and governance frameworks.

The analysis further highlights the structural limitations of global university rankings as proxies for higher education quality. Ranking methodologies strongly favor research-intensive, English-speaking institutions and rely heavily on bibliometric indicators, thereby marginalizing dimensions such as inclusiveness, teaching effectiveness, and societal impact. As a result, rankings tend to reproduce existing inequalities rather than provide a comprehensive assessment of institutional value.

Overall, the findings support the study's hypothesis that stronger investment in R&D is associated with higher-ranked universities and greater national commitment to innovation. At the same time, they reinforce the need for more transparent, multidimensional, and context-sensitive evaluation frameworks that better reflect the diverse missions of higher education institutions and their role in sustainable socio-economic development. Rankings can

offer useful benchmarking insights, but they should be interpreted cautiously and complemented by broader quality assurance and impact-based assessment approaches.

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