ARTICLE

The research productivity profiles of the Philippines' most research productive higher education institutions: Analyses by regional clusters and ownership types

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ABSTRACT

Using SciVal, this article examines the bibliometric data of the Philippines' most research-productive higher education institutions (HEIs) to provide policy recommendations that will collectively boost the research production of the country. The study reveals that 1) NCR leads in the bulk research production, number of authors, citations per paper, percentage of papers in the top 10% journals, percentage of papers with international collaboration, and percentage of papers with corporate collaboration. However, statistically significant differences among these regionally clustered most research-productive Philippine HEIs are limited to bulk research production, number of authors, and percentage of papers with corporate collaboration; 2) Privately-owned HEIs perform much better than publicly-owned HEIs, but the statistical differences are limited only to bulk research production and number of authors; 3) the statistically significant correlations among the bibliometric data are limited to bulk research production and number of authors, bulk research production and number of citations, number of authors and number of citations, number of authors and percentage of papers with institutional collaboration, and number of citations per paper and percentage of papers in top 10% journals. These results underscore that in a knowledge-based economy where research production is recognized as a key element in building the competitive edge of any industrialized country, there is an urgent need for the country's policymakers and HEI research managers to monitor the trends in the research productivity of the Philippines' most research-productive HEIs.

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INTRODUCTION

The Philippines has shown development in research during the last decade but still lags behind its neighboring countries. The number of papers that are Scopus Indexed has increased on average by 13.33% per year from 2012 to 2021 (Dela Cruz et al. 2023). Figure 1 shows the Scopus papers production, as a proxy measure of research productivity, of the ASEAN countries from the past decade. It reveals the below-average research production of the Philippines with no immediate signs of moving nearer the ASEAN average research production curve. Meanwhile, the dramatic increases in the research production curves of Indonesia, Malaysia, and Vietnam are products of central government policy changes based on these countries' understanding of the relationship between research production and national competitiveness in a knowledge-based global economy. Examples of these policy changes are the establishment of the Malaysian research universities, the imposition of publication requirements on Indonesian professors and students, and the redirection of the research budget to Vietnamese universities.

The Philippines is somewhat aware of its underperformance in research. Its Commission on Higher Education (CHED) issued the Commission Memorandum Order (CMO) 46 in 2012, trying to impose a typology on Philippine higher educational institutions (HEIs) with the intention, among others, to coax its capable HEIs to accelerate their research productions; and the CMO 15 in 2019, pressuring its graduate program professors and students to undertake research and publications more seriously. However, if the central government of the Philippines does not belatedly make conscious efforts and policy changes comparable to those in Malaysia and Indonesia, the country's development pace cannot keep up with ASEAN's average trend.

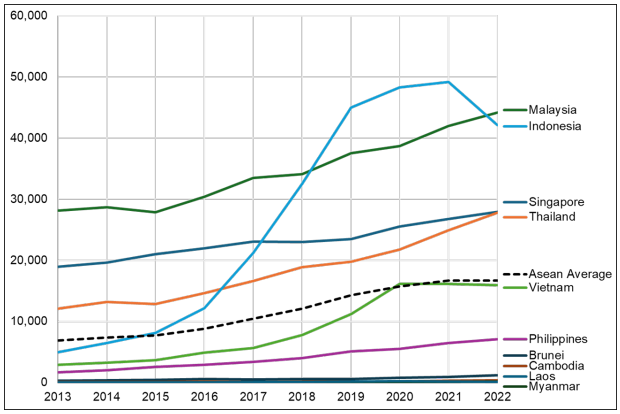

Figure 1: Scopus Papers Production of the ASEAN Countries

Joint efforts are urgently needed to develop and implement appropriate initiatives for empowering Filipino researchers to share their findings with policymakers and align their research projects with emerging post-pandemic sustainable agendas. There is also a need to set up mechanisms, incentives, and programs to sustain the motivation of researchers to take part in research projects. In addition, the education agencies in the Philippines could provide support and resources to HEIs so that Filipino teachers can act as leaders of joint research projects, thereby promoting and strengthening mentorship, collaboration, and internationalization.

Various published studies provide a picture of the state of knowledge production in Philippine HEIs and shed light on the objectives of this study. Among those that zeroed in on Philippine research productivity include the articles of Rosario et al. (2022), that developed research productivity score (RPS) from the leveling instrument of the Commission on Higher Education (CHED) for state colleges and universities (SUCs), specifically on research capability and output; Alcazaren (2021), that outlined the factors and consequences of research productivity as a capital in the context of Philippine academics; Mala and Canencia (2021), that determined the significant relationship of research productivity of faculty members in Mindanao State University System and their ethnicity and geographical location; Bueno (2019), that presented major factors negatively affecting scientific research and publications among professorial lecturers from various higher educational institutions in the Philippines; Gravoso et al. (2016), that examined the research productivity in Development Communication in the Philippines; Quimbo and Sulabo (2014), that analyzed the research productivity of selected higher education institutions covering five state universities in the Philippines; and, Navarrete and Asio (2014), that elucidated the trend in the soil science publications using Thomson ISI database. It is interesting to note from the study of Quimbo and Sulabo (2014) that educational attainment, research benefits, and incentive systems are important predictors of both research self-efficacy and research productivity. Self-efficacy has also been found to be a significant determinant of productivity, highlighting the need to have a strong faculty development program, enhanced research collaboration, improved research productivity, and functional incentive system in order to promote and enhance the research culture in higher education institutions. The present study is important because it will utilize SciVal, a bibliometric analytic application of Elsevier, to look at the bibliometric data of the Philippines' most research productive HEIs with the aim of coming up with policy recommendations to boost its collective research production.

Meanwhile, there are a few studies on public-private HEIs research productivity. This includes articles of Rogayan and Corpuz (2022) that evaluated the research productivity of a state university in Central Luzon (2016-2020); Ambong et al. (2020), that explored the research productivity in Occidental Mindoro State College based on State Universities and Colleges Levelling indicators of the Commission on Higher Education and the Program Expenditure Classification indicators of the Department of Budget and Management for Research Program of a Philippine HEI; Gamuza and Pacolor (2019), that correlated leadership orientation of HEIs top and middle-level managers to institutions' research productivity such as publications, citations, inventions, and awards received; Tullao and Regadio (2015), that assessed SUC's utilization of Research and Development (R&D) funding and evaluated its global significance and impact, while comparing it with the R&D output of selected private HEIs in Scopus; Cocal et al. (2017), that assessed the factors limiting research productivity of the faculty members of the Pangasinan State University Alaminos City Campus; and Esponilla (2015), that identified research motivators that significantly influence research productivity in Technological University of the Philippines Manila campus. It is important to note that none of these studies identified bibliometric aspects that best predict the bulk research production, number of authors, number of citations, and number of citations per paper within the context of the most research-productive Philippine HEIs.

Moreover, fewer studies on cross-country research productivity were conducted, including the articles of Guido and Orleans, A. V. (2020), that presented Philippine research productivity as compared to the other seven Southeast Asian countries with the aim of providing a systematic analysis of the progress and current state of research productivity of the Philippines in the context of education research among Scopus journal publications; and Vinluan (2012), that assessed research productivity in education and psychology in the Philippines

using bibliometric indicators and was then benchmarked against its Southeast Asian neighbors' research productivity in the same fields. None of these studies provided a methodology for studying the research production of various collections of HEIs of a given country or even between countries.

By using SciVal, a bibliometric analytic application of Elsevier, this paper looks at the bibliometric data of the Philippines' most research productive HEIs with the aim of coming up with policy recommendations to boost its collective research production. SciVal's main competitor is InCites of Clarivate. This paper opted to use SciVal for the mundane reason that it is the available application of their lead university base. Subscriptions to these applications can be very expensive. More specifically, this paper addresses the following research problems:

1. What significant statistical differences exist among the regionally-clustered (National Capital Region or NCR, Balance Luzon or Luzon areas sans NRC, Visayas, and Mindanao) most research-productive Philippine HEIs in the following bibliometric aspects?
   - bulk research production
   - number of authors
   - citations per paper
   - percentage of papers in the top 10% journals
   - percentage of papers with international collaboration
   - percentage of papers with corporate collaboration

2. How do private and public HEIs differ in the same bibliometric aspects mentioned in the first problem?

3. Which among these bibliometric aspects most significantly influences the bulk research production?
   - number of authors
   - number of citations
   - number of citations per paper
   - percentage of papers in the top 10% journals
   - percentage of papers with international collaboration
   - percentage of papers with national collaboration
   - percentage of papers with institutional collaboration
   - percentage of papers with single authorship or percentage of papers with corporate collaboration

4. Which among these bibliometric aspects most significantly influences the number of authors?
   - number of citations
   - number of citations per paper
   - percentage of papers in the top 10% journals
   - percentage of papers with international collaboration
   - percentage of papers with national collaboration
   - percentage of papers with institutional collaboration
   - percentage of papers with single authorship or percentage of papers with corporate collaboration

5. Which among these bibliometric aspects most significantly influences the number of citations?
   - number of citations per paper
   - percentage of papers in the top 10% journals
   - percentage of papers with international collaboration
   - percentage of papers with national collaboration
   - percentage of papers with institutional collaboration
   - percentage of papers with single authorship or percentage of papers with corporate collaboration

6. Which among these bibliometric aspects most significantly influences the number of citations per paper?
   - percentage of papers in the top 10% journals
   - percentage of papers with international collaboration
   - percentage of papers with national collaboration
   - percentage of papers with institutional collaboration
   - percentage of papers with single authorship or percentage of papers with corporate collaboration

This paper is significant in the sense that it analyzes whether there is an imbalance in the research production and other pertinent metrics among the HEIs located in NCR, Balance Luzon, Visayas, and Mindanao. The Philippines is an archipelago with more than 7,000 islands, regionally clustered as Luzon in the north, Visayas in the center, and Mindanao in the south. Within the Luzon cluster, particularly on the Island of Luzon, is a sub-cluster of 16 cities and one municipality, collectively known as Metro Manila or NCR. Central government policies and development patterns are usually flagged by people outside NCR as Metro Manila-centric. This paper reveals whether Metro Manila-centrism is present as well in the way research is undertaken in the country. This paper is also significant in the sense that it analyzes whether there is an imbalance in the research production and other pertinent metrics among the country's privately-owned and publicly-owned HEIs. The Philippines has 1,906 HEIs, of which 1,673 (87.78%) are privately-owned, and 233 (12.22%) are publicly-owned. This paper is further significant in the sense that it identifies the bibliometric aspects that best predict the bulk research production, number of authors, number of citations, and number of citations per paper within the context of the most research-productive Philippine HEIs. Such findings can be useful to any Philippine HEI that intends to increase its research production or scores in the pertinent bibliometric, as well as to CHED, as it tries to orchestrate a significant increase in the country's research production. This paper is also significant for higher education studies in the sense that it provides a methodology for studying the research production of various collections of HEIs of a given country or even between countries.

METHODOLOGY

Using SciVal, this paper isolated 61 Philippine institutions that produced Scopus papers from 2018 to 2022. After eliminating the non-HEIs, such as International Rice Research Institute and Asian Development Bank, and HEIs with campuses that go beyond one regional cluster, specifically the University of the Philippines and Polytechnic University of the Philippines, this paper was able to identify 49 HEIs, as presented in table 1.

Table 1: Most Research-Productive Philippine HEIs

Regional Cluster	Type of Ownership	Number of HEIs	Percentage	Total Number of HEIs	Percentage
National Capital Region	Private	13	92.86%	14	28.57%
	Public	1	7.14%		
Balance Luzon	Private	3	23.08%	13	26.53%
	Public	10	76.92%		
Visayas	Private	5	41.67%	12	24.49%
	Public	7	58.33%		

Mindanao	Private	2	20.00%	10	20.41%
	Public	8	80.00%		
Total	Private	23	46.94%	49	100.00%
	Public	26	53.06%		

Table 1 shows that the most research-productive Philippine HEIs are predominated by the publicly-owned HEIs (53.06%:46.94%). This predominance is true in all of the regional clusters, except in NCR. The overall predominance of publicly-owned HEIs becomes more emphasized if the figures 26 and 23 are compared with the Philippines' total number of publicly-owned (233) and privately-owned HEIs (1,673): 26 is 11.16% of the publicly-owned HEIs, while 23 is just 1.37% of the privately-owned HEIs. This means that privately-owned HEIs are largely underrepresented among the most research-productive Philippine HEIs. It must be noted that the 26 publicly-owned HEIs all belong to state universities and colleges (SUCs), a special sub-set of publicly-owned HEIs. Table 1 also shows that NCR (14, or 28.57%) has the biggest number of most research-productive HEIs, which is followed by Balance Luzon (13, or 26.53%), then by Visayas (12, or 24.49%), and with Mindanao (10, or 20.41%) having the least number.

On September 24, 2023, the scores of these 49 HEIs were retrieved from SciVal on the following bibliometric aspects: bulk research production, number of authors, number of citations, citations per paper, percentage of papers in top 10% journals, percentage of papers with international collaboration, percentage of papers with national collaboration, percentage of papers with institutional collaboration, percentage of papers with single authorship, and percentage of papers with corporate collaboration. These anonymized data are presented as Appendix A of this paper.

To address the research questions outlined in this study, we employed a combination of statistical tests to analyze the bibliometric data. A detailed overview of the statistical methods utilized, including their assumptions and rationale, are provided below:

1. Cluster Analysis: HEIs were initially clustered based on regional and ownership types to explore potential variations in bibliometric aspects across different clusters. This clustering approach aimed to identify patterns and differences within the dataset.
2. One-Way ANOVA and Tukey's HSD Test: In addressing the first research problem, where HEIs were regionally clustered, we conducted one-way analysis of variance (ANOVA) followed by Tukey's Honestly Significant Difference (HSD) test. These tests were utilized to compare scores across multiple bibliometric aspects, such as bulk research production, number of authors, citations per paper, percentage of papers in the top 10% journals, percentage of papers with international collaboration, and percentage of papers with corporate collaboration. The purpose was to determine whether significant differences existed in these aspects among different regional clusters of HEIs.
3. T-Test: For the second research problem, HEIs were re-clustered based on ownership types. Subsequently, t-tests were employed to compare their scores on the same bibliometric aspects examined in the first research problem. This analysis aimed to investigate potential disparities in bibliometric performance based on ownership types.
4. Multiple Regression Analyses: To address the third, fourth, fifth, and sixth research problems, where HEIs were non-clustered, multiple regression analyses were conducted. These analyses explored the relationships between bulk research production, number of authors, number of citations per paper, and their pertinent bibliometric aspects. The objective was to assess the impact of these variables on bibliometric performance.

Furthermore, the statistical analyses were conducted using Microsoft Excel and Data Tab Statistics Calculator.

Ethical Consideration

This project did not involve human participants and relied purely on the data from Scival, which are available to the researchers through institutional access. The identities of the HEIs were anonymized to protect their reputations. Furthermore, a research ethics clearance was secured from the home institution of one of the research team members.

Regional Clustering of Philippine HEIs

This section addresses the first research problem that focused on the significant statistical differences among the regionally-clustered most research-productive HEIs in terms of the following bibliometric aspects: bulk research production, number of authors, citations per paper, percentage of papers in the top 10% journals, percentage of papers with international collaboration, and percentage of papers with corporate collaboration. The data set for this section is presented in Appendix A.

Bulk Research Production: Table 2 presents the results of a One-Way ANOVA on the bulk research productions of the regionally-clustered HEIs: NCR (M=774.00), Balance Luzon (M=112.77), Visayas (M=144.17), and Mindanao (M=192.30).

Table 2: One-Way ANOVA Results on NCR, Balance Luzon, Visayas, and Mindanao HEIs' Bulk Research Production

Source	Sum of Squares	df	Mean Square	F	p
Between-Treatments	3976441.558	3	1325480.519	3.643	.0195
Within-Treatments	16373402.074	45	363853.379		
Total	20349843.633	48			

(where df = degrees of freedom, F = F-statistic, P = P-value)

Table 2 shows that the One-Way ANOVA revealed a statistically significant difference in the mean bulk research productions between at least two regionally clustered HEIs ($F(3, 45)=[3.6443]$, $p=0.0195$). Table 3 presents the results of a Tukey's HSD Test on the bulk research productions of the same regionally-clustered HEIs.

Table 3: Tukey's HSD Test Results on NCR, Balance Luzon, Visayas, and Mindanao HEIs' Bulk Research Production

Pairwise Comparisons		Mean Difference $HSD_{.05}$=655.312 $HSD_{.01}$=809.643	Q $Q_{.05}$=3.773 $Q_{.01}$=4.661
NCR:Balance Luzon	M_1=774.00 M_2=112.77	661.23	3.81 (p=.0472)
NCR:Visayas	M_1=774.00 M_3=144.17	629.83	3.63 (p=.0636)
NCR:Mindanao	M_1=774.00 M_4=192.30	581.70	3.35 (p=.0981)
Balance Luzon:Visayas	M_2=112.77 M_3=144.17	31.40	0.18 (p=.9992)
Balance Luzon:Mindanao	M_2=112.77 M_4=192.30	79.53	0.46 (p=.9881)
Visayas:Mindanao	M_3=144.17 M_4=192.30	48.13	0.28 (p=.9973)

(where M=Mean Difference, HSD = Honestly Significant Difference, Q = Q value)

Table 3 shows how Tukey's HSD Test pinpointed that this statistically significant difference is only between the mean bulk research productions of NCR and Balance Luzon ($Q=3.81$, $p=0.0472$).

Number of Authors: Table 4 presents the results of a One-Way ANOVA on the number of authors of the regionally-clustered HEIs: NCR (M=872.29), Balance Luzon (M=120.15), Visayas (M=124.58), and Mindanao (M=161.40).

Table 4: One-Way ANOVA Results on NCR, Balance Luzon, Visayas, and Mindanao HEIs' Number of Authors

Source	Sum of Squares	df	Mean Square	F	p
Between-Treatments	5469730.256	3	1823243.4188	5.074	.0041
Within-Treatments	16169825.866	45	359329.4637		
Total	21639556.122	48			

(where df = degrees of freedom, F = F-statistic, P = P-value)

Table 4 shows that the One-Way ANOVA revealed a statistically significant difference in the mean number of authors between at least two regionally clustered HEIs (F(3, 45)=[5.074], p=0.0041). Table 5 presents the results of a Tukey's HSD Test on the number of authors of the same regionally-clustered HEIs.

Table 5: Tukey's HSD Test Results on NCR, Balance Luzon, Visayas, and Mindanao HEIs' Number of Authors

Pairwise Comparisons		Mean Difference $HSD_{.05}$=651.226 $HSD_{.01}$=804.594	Q $Q_{.05}$=3.773 $Q_{.01}$=4.661
NCR:Balance Luzon	M_1=872.29 M_2=120.15	752.13	4.36 (p=.0178)
NCR:Visayas	M_1=872.29 M_3=124.58	747.70	4.33 (p=.0187)
NCR:Mindanao	M_1=872.29 M_4=161.40	710.89	4.12 (p=.0275)
Balance Luzon:Visayas	M_2=120.15 M_3=124.58	4.43	0.03 (p=.0000)
Balance Luzon:Mindanao	M_2=120.15 M_4=161.40	41.25	0.24 (p=.9983)
Visayas:Mindanao	M_3=124.58 M_4=161.40	36.82	0.21 (p=.9988)

Number of Citations per Paper: Table 6 presents the results of a One-Way ANOVA on the number of citations per paper of the regionally-clustered HEIs: NCR (M=5.13), Balance Luzon (M=3.31), Visayas (M=5.72), and Mindanao (M=7.34).

Table 6: One-Way ANOVA Results on NCR, Balance Luzon, Visayas, and Mindanao HEIs' Number Citations per Paper

Source	Sum of Squares	df	Mean Square	F	p
Between-Treatments	95.540	3	31.847	2.589	.1445
Within-Treatments	553.518	45	12.300		
Total	649.058	48			

(where df = degrees of freedom, F = F-statistic, P = P-value)

Table 6 shows that the One-Way ANOVA revealed no statistically significant difference in the mean number of citations per paper among any of the regionally clustered HEIs (F(3, 45)=[2.589], p=0.1445).

Percentage of Papers in Top 10% Journals: Table 7 presents the results of a One-Way ANOVA on the percentage of papers in top 10% journals of the regionally-clustered HEIs: NCR (M=12.84%), Balance Luzon (M=6.31%), Visayas (M=9.94%), and Mindanao (M=12.68%).

Table 7: One-Way ANOVA Results on NCR, Balance Luzon, Visayas, and Mindanao HEIs' Percentage of Papers in Top 10% Journals

Source	Sum of Squares	df	Mean Square	F	p
Between-Treatments	355.702	3	118.567	1.892	.1445
Within-Treatments	2820.389	45	62.675		
Total	3176.091	48			

(where df = degrees of freedom, F = F-statistic, P = P-value)

Table 7 shows that the One-Way ANOVA revealed no statistically significant difference in the mean percentage of papers in top 10% journals among any of the regionally clustered HEIs (F(3, 45)=[1.892], p=0.1445).

Percentage of Papers with International Collaboration: Table 8 presents the results of a One-Way ANOVA on the percentage of papers with international collaboration of the regionally-clustered HEIs: NCR (M=29.83%), Balance Luzon (M=29.59%), Visayas (M=30.45%), and Mindanao (M=37.12%).

Table 8: One-Way ANOVA Results on NCR, Balance Luzon, Visayas, and Mindanao HEIs' Percentage of Papers with International Collaboration

Source	Sum of Squares	df	Mean Square	F	p
Between-Treatments	415.064	3	138.355	0.538	.6585
Within-Treatments	11566.044	45	257.023		
Total	11981.108	48			

(where df = degrees of freedom, F = F-statistic, P = P-value)

Table 8 shows that the One-Way ANOVA revealed no statistically significant difference in the mean percentage of papers with international collaboration among any of the regionally clustered HEIs (F(3, 45)=[0.538], p=0.6585).

Percentage of Papers with Corporate Collaboration: Table 9 presents the results of a One-Way ANOVA on the percentage of papers with corporate collaboration of the regionally-clustered HEIs: NCR (M=0.92%), Balance Luzon (M=1.08%), Visayas (M=2.54%), and Mindanao (M=4.92%).

Table 9: One-Way ANOVA Results on NCR, Balance Luzon, Visayas, and Mindanao HEIs' Percentage of Papers with Corporate Collaboration

Source	Sum of Squares	df	Mean Square	F	p
Between-Treatments	114.639	3	38.213	3.199	.0322
Within-Treatments	537.552	45	11.946		
Total	652.191	48			

(where df = degrees of freedom, F = F-statistic, P = P-value)

Table 9 shows that the One-Way ANOVA revealed a statistically significant difference in the mean percentage of papers with corporate collaboration between at least two regionally clustered HEIs (F(3, 45)=[3.199], p=0.0322). Table 10 presents the results of a Tukey's HSD Test on the percentage of papers with corporate collaboration of the same regionally-clustered HEIs.

Table 10: Tukey's HSD Test Results on NCR, Balance Luzon, Visayas, and Mindanao HEIs' Percentage of Papers with Corporate Collaboration

Pairwise Comparisons		Mean Difference $HSD_{.05}$=3.755 $HSD_{.01}$=4.639	Q $Q_{.05}$=3.773 $Q_{.01}$=4.661
NCR:Balance Luzon	M_1=0.92% M_2=1.08%	0.16	0.16 (p=.9995)
NCR:Visayas	M_1=0.92% M_3=2.54%	1.62	1.63 (p=.6602)
NCR:Mindanao	M_1=0.92% M_4=4.92%	4.00	4.02 (p=.0329)
Balance Luzon:Visayas	M_2=1.08% M_3=2.54%	1.46	1.47 (p=.7266)
Balance Luzon:Mindanao	M_2=1.08% M_4=4.92%	41.25	0.24 (p=.9983)
Visayas:Mindanao	M_3=2.54% M_4=4.92%	36.82	0.21 (p=.9988)

(where M=Mean Difference, HSD = Honestly Significant Difference, Q = Q value)

Table 10 shows how the Tukey's HSD Test pinpointed that this statistically significant difference is only between mean percentage of papers with corporate collaboration of NCR and Mindanao (Q=4.02, p=.0329), and Balance Luzon and Mindanao (Q=3.86, p=.0431).

Discussion: The statistically significant differences among the regionally clustered most research-productive Philippine HEIs are limited only in the bibliometric aspects of bulk research

production, number of authors, and percentage of papers with corporate collaboration. There are no statistically significant differences in the bibliometric aspects of the number of citations per paper, percentage of papers in the top 10% journals, and percentage of papers with international collaboration.

In terms of bulk research production, the statistically significant difference is limited only to that between NCR (M=774.00) and Balance Luzon (M=112.77). Balance Luzon's geographic proximity to NCR could be the reason why its capacity to produce research is overpowered by the magnetic presence of the megalopolitan NCR. Visayas (M=144.17) and Mindanao's (M=192.30) bulk research productions are actually closer to that of Balance Luzon than to that of NCR, but such are not enough to create statistically significant differences. Their geographic distance to NCR could be the reason why their capacities to produce research are not so affected by the overbearing shadow of NCR.

In terms of the number of authors, the statistically significant differences are more widespread and are between NCR (M=872.29) on one hand and Balance Luzon (M=120.15), Visayas (M=124.58), and Mindanao (M=161.40) on the other hand. The concentration of about 12% of the country's total population in NCR gives this regional cluster easy access to quality human resources. It is in the aspect of the number of authors where the famous Metro Manila-centrism is fully felt. It is disappointing why this advantage in human resources was not translated into full advantages in the other aspects of SciVal's bibliometric data.

In terms of percentage of papers with corporate collaboration, the statistically significant differences are limited only to that between NCR (M=0.92%) and Mindanao (M=4.92%), and between Balance Luzon (M=1.08%) and Mindanao (M=4.92%). In this bibliometric aspect, the dominance is wielded by Mindanao. The concentration of science and technology, and agro-industry-leaning HEIs under the Mindanao cluster could be the basis of this dominance.

These statistical analyses of the regionally clustered most research-productive Philippine HEIs might have tarnished the legend of Metro Manila-centrism, but NCR's concentration of human resources, in the form of the number of authors, holds so much developmental promise. The right policies and incentives can readily convert this potential into actual advantages in the other areas of SciVal bibliometric data.

Ownership-Type Clustering of Philippine HEIs

This section addresses the second research problem that focused on the significant statistical differences among the ownership-type clustered most research-productive HEIs in terms of the following bibliometric aspects: bulk research production, number of authors, citations per paper, percentage of papers in the top 10% journals, percentage of papers with international collaboration, and percentage of papers with corporate collaboration. The data set for this section is presented in Appendix B.

Bulk Research Production: A T-Test reveals that there is a statistically significant difference in the bulk research production between the privately-owned and publicly-owned most research-productive HEIs, t(47)=1.956, p=0.0282, with the privately-owned HEIs performing better (M=513.57) than the publicly-owned HEIs (M=159.35).

Number of Authors: A T-Test reveals that there is a statistically significant difference in the number of authors between the privately-owned and publicly-owned most research-productive HEIs, t(47)=2.206, p=0. 0161, with the privately-owned HEIs having more (M=561.00) than the publicly-owned HEIs (M=153.08).

Number of Citations per Paper: A T-Test reveals that there is no statistically significant difference in the number of citations per paper between the privately-owned and publicly-owned most research-productive HEIs, t(47)=0.600, p=0.2757, despite the privately-owned HEIs having more (M=5.58) than the publicly-owned HEIs (M=4.94).

Percentage of Papers in Top 10% Journals: A T-Test reveals that there is no statistically significant difference in the percentage of papers published in top 10% journals between the privately-owned and publicly-owned most research-productive HEIs, t(47)=1.213, p=0.1156, despite privately-owned HEIs having more (M=11.86%) than the publicly-owned HEIs (M=9.05%).

Percentage of Papers with International Collaboration: A T-Test reveals that there is no statistically significant difference in the percentage of papers with international collaboration between the privately-owned and publicly-owned most research-productive HEIs, t(47)=-1.423, p=0.0806, despite privately-owned HEIs having more (M=32.55%) than the publicly-owned HEIs (M=30.41%).

Percentage of Papers with Corporate Collaboration: A T-Test reveals that there is no statistically significant difference in the percentage of papers with corporate collaboration between the privately-owned and publicly-owned most research-productive HEIs, t(47)=0.465, p=0.3222, despite publicly-owned HEIs having more (M=2.87%) than the privately-owned HEIs (M=1.39%).

Discussion: The statistically significant differences among the ownership-type clustered most research-productive Philippine HEIs are limited only in the bibliometric aspects of bulk research production, and number of authors. There are no statistically significant differences in the aspects of number of citations per paper, percentage of papers in top 10% journals, percentage of papers with international collaboration, and percentage of papers with corporate collaboration.

In terms of research production volume, privately-owned Higher Education Institutions (HEIs) outshine their publicly-owned counterparts, with an average output of 513.57 compared to 159.35, respectively. This trend extends to authorship, where privately-owned HEIs exhibit higher participation, averaging 561.00 authors compared to 153.08 for publicly-owned HEIs. Government grants and scholarships such as CHED's Research Grants for Higher Education Institutions (HEIs) and DOST's Science and Technology Scholarships, Grants, and Funding Programs are instrumental in shedding light on grant initiatives aimed at bolstering research capabilities within Philippine HEIs. These documents underscore ongoing efforts to amplify funding avenues and resources for these institutions.The observed disparity is noteworthy given the expectation that publicly-owned HEIs, benefiting from national funding and priority access to government-controlled grants, would lead in research productivity. It's worth noting, however, that some publicly-owned HEIs, although excluded from analysis due to multi-campus locations across regional clusters, are among the nation's most prolific research contributors. Nevertheless, this discrepancy warrants examination by the central government to understand the root causes behind the gap in both research output and authorship. Addressing this imbalance is crucial for

fostering a more equitable and robust research landscape within Philippine HEIs.

These privately-owned HEIs head start in developing research capacity and their uncentralized governance that made them efficient and agile could be the reason for this pattern of dominance. It is unfortunate that the privately-owned HEIs' dominance in bulk research production and number of authors was not translated into dominance in the other aspects of SciVal's bibliometric data. But the right policies and incentives can readily convert this dominance into actual advantages in the said other aspects. It should be remembered that the 23 privately-owned HEIs included in this paper are just 1.37% of the country's total number of privately-owned HEIs. But this elite group of Philippine HEIs holds great potential in developing further research in the whole country.

Multiple Regression Analyses of the Unclustered HEIs

This section addresses the third, fourth, fifth, and sixth research problems that focus on identifying the bibliometric aspects that strongly correlate with the bulk research production, number of authors, number of citations, and number of citations per paper. The data set for this section is presented in Appendix C.

Bulk Research Production: A multiple regression was run to examine the relationship of bulk research production from number of authors, number of citations, number of citations per paper, percentage of papers in top 10% journals, percentage of papers with international collaboration, percentage of papers with national collaboration, percentage of papers with institutional collaboration, percentage of papers with single authorship, and percentage of papers with corporate collaboration. Table 11 presents its results.

Table 11: Multiple Regression for Bulk Research Production with Nine Predictors

Summary Output

Regression Statistics	
Multiple R	0.986
R Square	0.972
Adjusted R Square	0.965
Standard Error	121.916
Observations	49

ANOVA

	df	*SS*	*MS*	*F*	*P-Value*
Regression	9	19770164.200	2196684.911	147.790	.0000
Residual	39	579679.432	14863.575		
Total	48	20349843.633			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	-26.952	224.514	-0.120	.9051
Number of Authors	0.427	0.054	7.840	.0000
Number of Citations	0.091	0.008	12.102	.0000
Number of Citations per Paper	-11.974	6.258	-1.913	.0631
Percentage of Papers in Top 10% Journals	-2.369	2.761	-0.858	.3961
Percentage of Papers with International Collaboration	-0.063	2.487	-0.025	.9800
Percentage of Papers with National Collaboration	2.402	2.624	0.916	.3655
Percentage of Papers with Institutional Collaboration	0.138	2.604	0.053	.9581
Percentage of Papers with Single Authorship	1.411	2.523	0.559	.5791
Percentage of Papers with Corporate Collaboration	0.072	5.517	0.013	.9897

(where *df* = degrees of freedom, SS = Sum of Squares, MS = Mean Square, F = F-statistic)

Table 11 shows that 96.49% of variance can be accounted for by the nine predictors collectively, F(9,39)=147.790, p=0.0000. But looking at the individual contributions of these nine predictors, the results show that only the number of authors (β=0.427, t=7.840, p=0.000) and the number of citations (β=0.091, t=12.102, p=0.000) positively influences bulk research production.

Number of Authors: A multiple regression was run to examine the relationship of number of authors from number of citations, number of citations per paper, percentage of papers in top 10% journals, percentage of papers with international collaboration, percentage of papers with national collaboration, percentage of papers with institutional collaboration, percentage of papers with single authorship, and percentage of papers with corporate collaboration. Table 12 presents its results.

Table 12: Multiple Regression for Number of Authors with Eight Predictors

Summary Output

Regression Statistics	
Multiple R	0.877
R Square	0.768
Adjusted R Square	0.722
Standard Error	354.036
Observations	49

ANOVA

	df	*SS*	*MS*	*F*	*P-Value*
Regression	8	16625889.503	2078236.188	16.581	0.0000
Residual	40	5013666.620	125341.665		
Total	48	21639556.122			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	3.826	651.972	0.006	0.9953
Number of Citations	0.110	0.013	8.273	0.0000
Number of Citations per Paper	-6.716	18.143	-0.370	0.7132
Percentage of Papers in Top 10% Journals	-6.864	7.944	-0.864	0.3927
Percentage of Papers with International Collaboration	2.300	7.214	0.319	0.7515
Percentage of Papers with National Collaboration	-1.663	7.614	-0.218	0.8282
Percentage of Papers with Institutional Collaboration	15.017	7.180	2.092	0.0429
Percentage of Papers with Single Authorship	-5.170	7.282	-0.710	0.4818
Percentage of Papers with Corporate Collaboration	-21.146	15.668	-1.350	0.1847

(where *df* = degrees of freedom, SS = Sum of Squares, MS = Mean Square, F = F-statistic)

Table 12 shows that 72.20% of variance can be accounted for by the eight predictors collectively, F(8,40)=16.581, p=0.0000. But looking at the individual contributions of these eight predictors, the results show that only the number of citations (β=0.110, t=8.273, p=0.000) and the percentage of institutional collaboration (β=15.017, t=2.092, p=0.0429) positively influence the number of authors.

Number of Citations: A multiple regression was run to examine the relationship of number of citations from number of citations per paper, percentage of papers in top 10% journals, percentage of papers with international collaboration, percentage of papers with national collaboration, percentage of papers with institutional collaboration, percentage of papers with single authorship, and percentage of papers with corporate collaboration. Table 13 presents its results.

Table 13: Multiple Regression for Number of Citations with Seven Predictors

Summary Output

Regression Statistics	
Multiple R	0.543
R Square	0.294
Adjusted R Square	0.174
Standard Error	4153.683
Observations	49

ANOVA

	df	*SS*	*MS*	*F*	*P-Value*
Regression	7	295182931.476	42168990.211	2.444	.0344
Residual	41	707376227.790	17253078.727		
Total	48	1002559159.265			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	1205.484	7646.856	0.158	.8755
Number of Citations per Paper	370.162	204.854	1.807	.0781
Percentage of Papers in Top 10% Journals	116.958	91.389	1.280	.2078
Percentage of Papers with International Collaboration	5.369	84.628	0.063	.9497
Percentage of Papers with National Collaboration	-85.831	88.321	-0.972	.3368
Percentage of Papers with Institutional Collaboration	61.403	83.690	0.734	.4673
Percentage of Papers with Single Authorship	-45.488	85.136	-0.534	.5960
Percentage of Papers with Corporate Collaboration	-151.596	182.292	-0.832	.4104

(where *df* = degrees of freedom, SS = Sum of Squares, MS = Mean Square, F = F-statistic)

Table 13 shows that only 17.40% of variance can be accounted for by the seven predictors collectively, F(7,41)= 16.581, p=0.0000. Furthermore, looking at the individual contributions of these seven predictors, the results show that none of the predictors are statistically significant positive predictors on the number of citations.

Number of Citations per Paper: A multiple regression was run to examine the relationship of number of citations papers from percentage of papers in top 10% journals, percentage of papers with international collaboration, percentage of papers with national collaboration, percentage of papers with institutional collaboration, percentage of papers with single authorship, and

percentage of papers with corporate collaboration. Table 14 presents its results.

Table 14: Multiple Regression for Number of Citations per Paper with Six Predictors

Summary Output

Regression Statistics	
Multiple R	0.605
R Square	0.367
Adjusted R Square	0.276
Standard Error	3.129
Observations	49

ANOVA

	df	*SS*	*MS*	*F*	*P-Value*
Regression	6	237.931	39.655	4.051	.0027
Residual	42	411.128	9.789		
Total	48	649.058			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0.681	5.759	0.118	0.9064
Percentage of Papers in Top 10% Journals	0.194	0.062	3.133	0.0031
Percentage of Papers with International Collaboration	0.032	0.064	0.508	0.6140
Percentage of Papers with National Collaboration	0.048	0.066	0.731	0.4686
Percentage of Papers with Institutional Collaboration	-0.013	0.063	-0.207	0.8366
Percentage of Papers with Single Authorship	-0.006	0.064	-0.099	0.9213
Percentage of Papers with Corporate Collaboration	0.195	0.134	1.454	0.1533

(where *df* = degrees of freedom, SS = Sum of Squares, MS = Mean Square, F = F-statistic)

Table 14 shows that 27.61% of variance can be accounted for by the six predictors collectively, $F(6,42)=14.051$, $p=0.0027$. But looking at the individual contributions of these six predictors, the results show that only the percentage of papers in top 10% journals ($\beta=0.194$, $t=3.133$, $p=0.0031$) is the only statistically significant predictor of the number of citations per paper.

Discussion: The statistically significant correlations are between bulk research production and number of authors, bulk research production and number citations, number of authors and number of citations, number of authors and percentage of papers with institutional collaboration, and number of citations per paper and percentage of papers in top 10% journals.

If the main concern of Philippine HEIs is to increase its bulk research production, the primary focus should be on increasing human resources, specifically increasing the number of authors. Moreover, if the goal of these HEIs is to increase their human resources in the form of number of authors, the strategy would be to intensify their intra-institutional collaborations.

However, should Philippine HEIs aim to increase their citations per paper, the strategy is to target their publications toward the top 10% journals. This task poses challenges as it requires highly capable researchers. While increasing the number of citations may not be a very valuable metric in itself, if Philippine HEIs would consider this as a training ground for eventually targeting the top 10% journals, the strategy for this is to increase their bulk research productions and numbers of authors.

Essentially, a comprehensive strategy emerges: Boost bulk research production and authorship numbers as foundation to prepare for the more ambitious goal of targeting the top-tier or top 10% journals while recognizing that such an endeavor demands proficient researchers. This holistic approach aligns institutional concerns with specific actions while providing a roadmap for Philippine HEIs in navigating the complex landscape of research productivity and impact.

CONCLUSION

In conclusion, this research paper delved into the intricate landscape of research productivity among Higher Education Institutions (HEIs) in the Philippines, shedding light on the nuanced factors contributing to their respective profiles. Through a comprehensive analysis of regional clusters and ownership types, it has identified vital patterns and variations in research output, providing valuable insights for policymakers, academic administrators, and stakeholders.

The research has demonstrated that research productivity is not uniform across the nation. Instead, it is influenced by regional dynamics, economic factors, and institutional characteristics. Identifying high-performing HEIs within specific regional clusters serves as a foundation for future targeted interventions to foster a culture of research and innovation.

Moreover, examining ownership types has revealed distinctive patterns in research productivity among public and private HEIs. Understanding these differences is crucial for formulating policies that address the unique challenges and opportunities institutions face based on their ownership structures. Public-private partnerships and targeted funding initiatives may prove instrumental in promoting research excellence across the spectrum.

This research has unveiled critical insights into the research productivity landscape of Higher Education Institutions (HEIs) in the Philippines. Figure 1 paints a concerning picture of the country's below-average research production, and the absence of an immediate trajectory toward the ASEAN average raises questions about its competitiveness in a knowledge-based global economy.

Acknowledging its underperformance, the Commission on Higher Education (CHED) has implemented initiatives such as Commission Memorandum Order (CMO) 46 in 2012 and CMO 15 in 2019 to catalyze research acceleration among HEIs. However, the effectiveness of these measures requires thorough examination.

The research problems addressed in this paper, spanning regional differences, ownership types, and predictive bibliometric aspects, provide a comprehensive understanding of the dynamics influencing research production in the Philippines. The significance of regional imbalances, mainly the Metro Manila-centric focus and disparities between privately-owned and publicly-owned HEIs, highlights the need for tailored interventions.

Policy Action Recommendations:

1. Regional Collaboration. Encourage collaborative research initiatives among HEIs within regional clusters. Establishing regional research networks can foster knowledge exchange, resource sharing, and collective efforts to address regional challenges.

2. Resource Allocation. Advocate for strategic resource allocation to HEIs based on their research productivity profiles. Tailored funding schemes and incentives can motivate institutions to enhance their research capabilities and contribute to national development goals.

3. CHED Initiative Evaluation: Conduct a thorough evaluation of the effectiveness of CHED's initiatives (CMO 46 and CMO 15) to identify areas of improvement and ensure alignment with the overarching goal of enhancing research productivity.

By implementing these recommendations, policymakers and academic leaders can work collaboratively to create an environment that nurtures and sustains research excellence in Philippine HEIs. This research serves as a diagnostic tool and a roadmap for steering the nation's academic landscape toward greater research productivity and societal impact.

This paper's significance extends beyond the borders of the Philippines, providing a methodology for studying research production in various HEI collections within a country or between countries. As the nation strives to enhance its research landscape, the findings of this research offer valuable insights and recommendations for policymakers, academic administrators, and institutions aiming to bolster their research capabilities and global competitiveness.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

CONTRIBUTIONS OF INDIVIDUAL AUTHORS

All authors contributed to the data gathering, analysis of the results, manuscript writing, and revision.

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Appendix A: Data Set for the Regionally Clustered HEIs

HEI CODE	Regional Cluster	Bulk Research Production	Mean	Number of Authors	Mean	Citations per Paper	Mean	Percentage of Papers in Top 10% Journals	Mean	Percentage of Papers with International Collaboration	Mean	Percentage of Papers with Corporate Collaboration	Mean
HEI08	Balance Luzon	384		390		4.7		7.5		36.5		0.0	
HEI12	Balance Luzon	248		191		2.3		3.8		14.1		0.0	
HEI18	Balance Luzon	165		214		5.3		9.9		29.7		0.0	
HEI23	Balance Luzon	130		153		5.3		5.0		20.0		0.0	
HEI25	Balance Luzon	120		145		4.9		2.9		20.0		0.8	
HEI29	Balance Luzon	96		173		4.0		12.2		32.3		1.0	
HEI31	Balance Luzon	89	112.77	73	120.15	4.8	3.31	12.0	6.31	47.2	29.59	1.1	1.08
HEI36	Balance Luzon	71		74		2.6		9.8		26.8		0.0	
HEI37	Balance Luzon	67		67		3.3		11.5		29.9		0.0	
HEI42	Balance Luzon	36		24		1.3		0.0		44.4		0.0	
HEI43	Balance Luzon	31		30		2.7		7.4		3.2		0.0	
HEI46	Balance Luzon	20		22		1.4		0.0		25.0		0.0	
HEI49	Balance Luzon	9		6		0.4		0.0		55.6		11.1	
HEI05	Mindanao	984		750		10.8		29.4		58.7		10.6	
HEI15	Mindanao	186		168		6.2		9.3		34.4		1.1	
HEI20	Mindanao	148		120		5.0		7.3		42.6		10.1	
HEI22	Mindanao	132		188		5.9		14.6		31.1		3.8	
HEI26	Mindanao	108	192.30	61	161.40	6.6	7.34	11.6	12.68	45.4	37.12	4.6	4.92
HEI27	Mindanao	108		103		4.7		3.9		16.7		2.8	
HEI30	Mindanao	95		55		20.5		13.0		37.9		1.1	
HEI35	Mindanao	72		52		2.4		11.8		41.7		2.8	
HEI39	Mindanao	51		77		6.6		15.4		29.4		2.0	
HEI40	Mindanao	39		40		4.7		10.5		33.3		10.3	
HEI01	NCR	3841		2948		6.2		15.0		30.4		1.1	
HEI02	NCR	1955		3379		3.6		7.9		19.7		0.2	
HEI03	NCR	1567		1123		10.6		22.8		36.6		2.5	
HEI04	NCR	1395		1835		8.6		17.0		48.6		3.4	
HEI06	NCR	583		634		3.5		2.0		5.0		0.0	
HEI09	NCR	384		561		6.2		19.6		27.1		0.3	
HEI11	NCR	277	774.00	523	872.29	2.8	5.13	9.9	12.84	20.6	29.83	0.0	0.92
HEI13	NCR	240		494		3.5		3.4		25.4		2.1	
HEI17	NCR	169		213		9.4		10.7		48.5		0.6	
HEI24	NCR	129		195		2.4		2.4		27.9		0.0	
HEI28	NCR	98		88		3.1		15.7		60.2		0.0	
HEI32	NCR	88		119		4.4		6.7		36.4		0.0	
HEI34	NCR	73		42		3.4		6.0		12.3		0.0	
HEI41	NCR	37		58		4.1		40.7		18.9		2.7	
HEI07	Visayas	530		442		10.6		24.7		51.3		5.3	
HEI10	Visayas	284		307		6.9		12.4		26.4		0.0	
HEI14	Visayas	216		205		10.8		17.6		50.5		4.2	
HEI16	Visayas	173		86		7.1		21.1		72.8		0.6	
HEI19	Visayas	161		159		1.9		6.1		13.7		2.5	
HEI21	Visayas	143	144.17	88	124.58	6.3	5.72	6.2	9.94	18.2	30.45	0.7	2.54
HEI33	Visayas	84		38		3.0		8.6		4.8		0.0	
HEI38	Visayas	55		69		2.1		0.0		9.1		0.0	
HEI44	Visayas	29		28		13.6		14.3		34.5		17.2	
HEI45	Visayas	25		28		3.2		0.0		32.0		0.0	
HEI47	Visayas	17		35		0.2		0.0		5.9		0.0	
HEI48	Visayas	13		10		2.9		8.3		46.2		0.0	

Appendix B: Data Set for the Ownership-Type Clustered HEIs

HEI CODE	Regional Cluster	Bulk Research Production	Mean	Number of Authors	Mean	Citations per Paper	Mean	Percentage of Papers in Top 10% Journals	Mean	Percentage of Papers with International Collaboration	Mean	Percentage of Papers with Corporate Collaboration	Mean
HEI01	Private	3841		2948		6.2		15.0		30.4		1.1	
HEI02	Private	1955		3379		3.6		7.9		19.7		0.2	
HEI03	Private	1567		1123		10.6		22.8		36.6		2.5	
HEI04	Private	1395		1835		8.6		17.0		48.6		3.4	
HEI06	Private	583		634		3.5		2.0		5.0		0.0	
HEI07	Private	530		442		10.6		24.7		51.3		5.3	
HEI09	Private	384		561		6.2		19.6		27.1		0.3	
HEI11	Private	277		523		2.8		9.9		20.6		0.0	
HEI16	Private	173		86		7.1		21.1		72.8		0.6	
HEI17	Private	169		213		9.4		10.7		48.5		0.6	
HEI18	Private	165		214		5.3		9.9		29.7		0.0	
HEI24	Private	129	513.57	195	561.00	2.4	5.58	2.4	11.86	27.9	32.53	0.0	1.39
HEI28	Private	98		88		3.1		15.7		60.2		0.0	
HEI29	Private	96		173		4.0		12.2		32.3		1.0	
HEI30	Private	95		55		20.5		13.0		37.9		1.1	
HEI32	Private	88		119		4.4		6.7		36.4		0.0	
HEI34	Private	73		42		3.4		6.0		12.3		0.0	
HEI38	Private	55		69		2.1		0.0		9.1		0.0	
HEI39	Private	51		77		6.6		15.4		29.4		2.0	
HEI41	Private	37		58		4.1		40.7		18.9		2.7	
HEI45	Private	25		28		3.2		0.0		32.0		0.0	
HEI47	Private	17		35		0.2		0.0		5.9		0.0	
HEI49	Private	9		6		0.4		0.0		55.6		11.1	
HEI05	Public	984		750		10.8		29.4		58.7		10.6	
HEI08	Public	384		390		4.7		7.5		36.5		0.0	
HEI10	Public	284		307		6.9		12.4		26.4		0.0	
HEI12	Public	248		191		2.3		3.8		14.1		0.0	
HEI13	Public	240		494		3.5		3.4		25.4		2.1	
HEI14	Public	216		205		10.8		17.6		50.5		4.2	
HEI15	Public	186		168		6.2		9.3		34.4		1.1	
HEI19	Public	161		159		1.9		6.1		13.7		2.5	
HEI20	Public	148		120		5.0		7.3		42.6		10.1	
HEI21	Public	143		88		6.3		6.2		18.2		0.7	
HEI22	Public	132		188		5.9		14.6		31.1		3.8	
HEI23	Public	130		153		5.3		5.0		20.0		0.0	
HEI25	Public	120	159.35	145	153.08	4.9	4.94	2.9	9.05	20.0	30.41	0.8	2.87
HEI26	Public	108		61		6.6		11.6		45.4		4.6	
HEI27	Public	108		103		4.7		3.9		16.7		2.8	
HEI31	Public	89		73		4.8		12.0		47.2		1.1	
HEI33	Public	84		38		3.0		8.6		4.8		0.0	
HEI35	Public	72		52		2.4		11.8		41.7		2.8	
HEI36	Public	71		74		2.6		9.8		26.8		0.0	
HEI37	Public	67		67		3.3		11.5		29.9		0.0	
HEI40	Public	39		40		4.7		10.5		33.3		10.3	
HEI42	Public	36		24		1.3		0.0		44.4		0.0	
HEI43	Public	31		30		2.7		7.4		3.2		0.0	
HEI44	Public	29		28		13.6		14.3		34.5		17.2	
HEI46	Public	20		22		1.4		0.0		25.0		0.0	
HEI48	Public	13		10		2.9		8.3		46.2		0.0	

Appendix C: Data Set for the Multiple Regression Analyses of Unclustered HEIs

HEI CODE	Bulk Research Production	Number of Authors	Number of Citations	Citations per Paper	H5-Index	Percentage of Papers in Top 10% Journals	Percentage of Papers with International Collaboration	Percentage of Papers with National Collaboration	Percentage of Papers with Institutional Collaboration	Percentage of Papers with Single Authorship	Percentage of Papers with Corporate Collaboration
HEI01	3841	2948	23869	6.2	45	15.0	30.4	19.2	35.2	15.2	1.1
HEI02	1955	3379	7098	3.6	25	7.9	19.7	13.8	65.1	1.4	0.2
HEI03	1567	1123	16684	10.6	35	22.8	36.6	20.9	22.4	20.0	2.5
HEI04	1395	1835	12057	8.6	36	17.0	48.6	20.4	21.3	9.8	3.4
HEI05	984	750	10650	10.8	39	29.4	58.7	21.0	17.9	2.3	10.6
HEI06	583	634	2017	3.5	15	2.0	5.0	52.0	40.7	2.4	0.0
HEI07	530	442	5633	10.6	29	24.7	51.3	23.6	19.6	5.5	5.3
HEI08	384	390	1814	4.7	18	7.5	36.5	34.4	24.0	5.2	0.0
HEI09	384	561	2395	6.2	19	19.6	27.1	33.3	32.8	6.8	0.3
HEI10	284	307	1953	6.9	17	12.4	26.4	41.5	24.6	7.4	0.0
HEI11	277	523	774	2.8	11	9.9	20.6	24.5	43.0	11.9	0.0
HEI12	248	191	580	2.3	8	3.8	14.1	29.0	23.0	33.9	0.0
HEI13	240	494	833	3.5	13	3.4	25.4	31.2	36.2	7.1	2.1
HEI14	216	205	2340	10.8	17	17.6	50.5	22.2	17.1	10.2	4.2
HEI15	186	168	1150	6.2	14	9.3	34.4	38.2	22.0	5.4	1.1
HEI16	173	86	1220	7.1	15	21.1	72.8	20.2	2.3	4.6	0.6
HEI17	169	213	1589	9.4	15	10.7	48.5	26.6	17.8	7.1	0.6
HEI18	165	214	879	5.3	9	9.9	29.7	31.5	27.3	11.5	0.0
HEI19	161	159	307	1.9	5	6.1	13.7	28.0	37.9	20.5	2.5
HEI20	148	120	746	5.0	11	7.3	42.6	35.1	10.8	11.5	10.1
HEI21	143	88	903	6.3	11	6.2	18.2	63.6	12.6	5.6	0.7
HEI22	132	188	775	5.9	13	14.6	31.1	29.5	31.8	7.6	3.8
HEI23	130	153	689	5.3	14	5.0	20.0	50.0	21.5	8.5	0.0
HEI24	129	195	315	2.4	7	2.4	27.9	19.4	28.7	24.0	0.0
HEI25	120	145	589	4.9	9	2.9	20.0	41.7	20.8	17.5	0.8
HEI26	108	61	712	6.6	10	11.6	45.4	41.7	7.4	5.6	4.6
HEI27	108	103	509	4.7	10	3.9	16.7	26.9	21.3	35.2	2.8
HEI28	98	88	303	3.1	8	15.7	60.2	13.3	7.1	19.4	0.0
HEI29	96	173	382	4.0	10	12.2	32.3	20.8	20.8	26.0	1.0
HEI30	95	55	1949	20.5	12	13.0	37.9	31.6	2.1	28.4	1.1
HEI31	89	73	429	4.8	9	12.0	47.2	28.1	9.0	15.7	1.1
HEI32	88	119	383	4.4	8	6.7	36.4	43.2	12.5	7.9	0.0
HEI33	84	38	250	3.0	6	8.6	4.8	16.7	5.9	72.6	0.0
HEI34	73	42	247	3.4	5	6.0	12.3	46.6	8.2	32.9	0.0
HEI35	72	52	174	2.4	4	11.8	41.7	50.0	6.9	1.4	2.8
HEI36	71	74	183	2.6	6	9.8	26.8	19.7	25.4	28.2	0.0
HEI37	67	67	218	3.3	6	11.5	29.9	50.8	11.9	7.5	0.0
HEI38	55	69	114	2.1	5	0.0	9.1	25.5	6.8	3.6	0.0
HEI39	51	77	336	6.6	8	15.4	29.4	49.0	11.8	9.8	2.0
HEI40	39	40	185	4.7	6	10.5	33.3	46.2	15.4	5.1	10.3
HEI41	37	58	153	4.1	5	40.7	18.9	18.9	27.0	35.1	2.7
HEI42	36	24	46	1.3	3	0.0	44.4	25.0	5.6	25.0	0.0
HEI43	31	30	83	2.7	4	7.4	3.2	22.6	38.7	35.0	0.0
HEI44	29	28	393	13.6	4	14.3	34.5	34.5	27.6	3.5	17.2
HEI45	25	28	81	3.2	4	0.0	32.0	32.0	4.0	32.0	0.0
HEI46	20	22	28	1.4	3	0.0	25.0	40.0	15.0	20.0	0.0
HEI47	17	35	3	0.2	0	0.0	5.9	11.8	64.7	17.6	0.0
HEI48	13	10	38	2.9	3	8.3	46.2	38.5	0.0	15.4	0.0
HEI49	9	6	4	0.4	1	0.0	55.6	0.0	22.2	22.2	11.1