



SCIENCE & TECHNOLOGY POLICY INSTITUTE

**International S&T Collaborations
at HBCUs, MSIs, and EPSCoR
Jurisdiction Institutions**

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Executive Summary

The 2022 International Science and Technology Coordination (ISTC) Report discusses the gap in understanding the participation of researchers from underrepresented groups in international collaborations and recommends exploring research on how international science and technology collaborations at Historically Black Colleges and Universities (HBCUs), other Minority-Serving Institutions (MSIs), and institutions in Established Program to Stimulate Competitive Research (EPSCoR) jurisdictions compare to appropriate peer institutions of higher education (IHEs). This report provides the first step to understanding how HBCUs, MSIs, and EPSCoR jurisdiction institutions participate in international science and technology collaborations by looking at the number and proportion of publications with international co-authors. In addition, it pulls from academic literature to help interpret the findings and proposes future studies to identify differences in international science and technology collaborations at HBCUs, MSIs, and EPSCoR jurisdiction institutions.

The bibliometric analyses, supported by academic literature, suggest that different institutional characteristics at HBCUs, MSIs, and EPSCoR jurisdiction institutions impact their international collaborations. Results indicate that MSIs have more international publications and a higher proportion of international publications compared to non-MSIs. EPSCoR jurisdiction institutions had similar numbers and proportions of international publications compared to peer IHEs in non-EPSCoR jurisdictions. The results indicate that HBCUs produce fewer international publications than their peer non-HBCU institutions, but the proportion of published HBCU research that includes at least one international collaborator is comparable to non-HBCU institutions. These findings suggest that more research is needed to better understand the institutional factors at HBCUs and the barriers they face collaborating internationally.

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1. Introduction

A. Overview of the Biennial Report to Congress on International Science and Technology Cooperation

The International Science and Technology Cooperation Act of 2016, part of the American Innovation and Competitiveness Act, instructs the Director of the White House Office and Science and Technology Policy (OSTP) to submit a biennial report on international science and technology (S&T) cooperation efforts to the Senate Committees on Commerce, Science, and Transportation and Foreign Relations and the House Committees on Science, Space, and Technology and Foreign Affairs (114th Congress 2017). The first report was submitted in 2020 by the National Science and Technology Council (NSTC) Subcommittee on International S&T Coordination (ISTC; Subcommittee on International Science & Technology Coordination 2020). The purpose of the ISTC is to enhance coordination of the Federal agencies' international S&T cooperation and partnerships, including addressing long-term strategic engagement goals, policy issues related to high-value international collaboration, and short-term country- and issue-specific priorities. ISTC submitted the second biennial report in 2022 (Subcommittee on International Science & Technology Coordination 2022).

The second biennial report contained 16 recommendations aimed at ensuring continued U.S. excellence in areas of successful international S&T engagement and addressing gaps in areas needing improvement. One of these gaps is the presence of underrepresented groups in STEM in international engagement (Subcommittee on International Science & Technology Coordination 2022). Although there has been research published on international collaboration networks and their development, neither current policies nor academic literature addresses how underrepresented groups participate in such networks. In preparation for the third biennial report, OSTP asked the IDA Science and Technology Policy Institute (STPI) to conduct research in response to recommendation 12 of the second ISTC biennial report:

Explore how researchers in both STEM [science, technology, engineering, and mathematics] and non-STEM fields at Historically Black Colleges and Universities (HBCUs), other Minority-Serving Institutions (MSIs), and institutions in Established Program to Stimulate Competitive Research (EPSCoR) jurisdictions are participating in international S&T collaborations, including as reflected in co-authored publications. Assess whether and how international engagement can act as a career accelerator for researchers and students from underrepresented groups and if

additional mechanisms may be needed to positively impact representation in international S&T settings.

B. Scope of Report

This report focuses on the first part of Recommendation 12, investigating co-authorships at HBCUs, other MSIs, and EPSCoR jurisdiction institutions. The results and discussion of this analysis are provided to the ISTC Subcommittee for consideration and incorporation into the third biennial report. Additional studies are needed to understand how international engagement acts as a career accelerator and identify if additional mechanisms are needed to positively impact representation in international S&T settings.

To examine international S&T collaborations by scholars at HBCUs, other MSIs, and EPSCoR jurisdiction institutions, STPI translated this research objective into a key study question:

- Do HBCUs, MSIs, and EPSCoR jurisdiction institutions collaborate internationally to the same degree as their peer institutions, as reflected in co-authored publications?

Considering there may be other institutional characteristics unique to each type of institution that affect international S&T collaboration activities, STPI identified a secondary research question to examine more carefully how HBCU, MSI, and/or EPSCoR status may affect international S&T collaboration:

- Which institutional characteristics of HBCU, MSI, and EPSCoR status institutions and their peer institutions impact the quantity of international S&T collaborations?

To answer the first study question, STPI conducted a bibliometric analysis of internationally co-authored publications at HBCUs, MSIs, and EPSCoR jurisdiction institutions and at peer institutions. To answer the second study question, STPI reviewed academic literature and spoke with subject-matter experts. There are many opportunities for follow-on work, including analysis of citation rates and differences in countries of collaboration and academic disciplines, as well as a further understanding of institutional characteristics of HBCUs, MSIs, and EPSCoR.

C. Background and Context

1. Literature Review of International S&T Research Collaboration

International S&T collaboration refers to any research activity jointly conducted by researchers in different countries toward a common scientific goal. “International collaboration” in research is not a rigorously defined term, and its qualifying boundaries can be unclear (Katz and Martin 1997). International collaboration can occur through

formal and informal partnerships: a partnership between individual researchers, an agreement between two institutions, or even a multinational initiative. In the field of international S&T collaboration, most studies define collaboration by international co-authorship (Beaver and Rosen 1978; Schubert and Braun 1990; Bidault and Hildebrand 2014; Chen et al. 2019; Katz and Martin 1997)—i.e., scientific articles with at least two co-authors who report institutional addresses in different countries.

International S&T collaboration is still an emerging field, so there is not extensive published literature. Most articles explore subjects within four research questions: how international S&T collaborations have increased over time, how rates of collaboration differ by scientific discipline, to what extent collaboration increases publications' citation impacts, and what motivates collaboration. Diversity, Equity, Inclusion, and Accessibility (DEIA) with respect to analysis of international S&T collaboration has received a lack of researcher attention.

According to the literature, the number of internationally co-authored publications has consistently increased over the past several decades (Beaver and Rosen 1978; Narin 1991; National Science Board 2000; Wagner and Leydesdorff 2005a; Wagner et al. 2017). Internationally co-authored publications have also increased in proportion to the overall number of scientific publications (Kwiek 2021; National Science Board 2000; Luukkonen et al. 1992; Wagner and Leydesdorff 2005a). This growth in international collaboration coincides with larger trends towards globalization. The complex and global nature of modern scientific problems and the ease with which researchers can remotely collaborate incentivize international collaboration (Gazni et al. 2012; Coccia and Wang 2016; Wagner et al. 2017). The literature indicates, however, that not all researchers benefited equally by this boon of international S&T collaboration (Schubert and Braun 1990; Wagner et al. 2001; Wagner and Leydesdorff 2005a).

At the individual level, researchers tend to seek partnerships that will most benefit their long-term career prospects, which exacerbate the inequities in the research community (Wagner and Leydesdorff 2005a). According to Wagner and Leydesdorff (2005a, 2005b), self-interested researchers are the driving force of international science collaboration. The work of Wagner and Leydesdorff indicates that researchers seek out collaborators who are already prolific and well-connected in a cycle of preferential attachment. Thus, researchers who are not as well-connected or established in their field may be excluded from international collaboration opportunities. Research collaboration is also important for individuals' career advancement, and several studies indicate that international collaboration leads to a higher citation impact (Narin 1991; Khor and Yu 2016; Potter et al. 2020; Glanzel 2001). According to Kwiek (2021), internationally collaborative publications can increase a researcher's prestige and open opportunities for research funding. In this way, elite researchers continue to publish high-visibility articles

and expand their collaborative network while others continue to struggle to establish themselves in the field.

This system of *preferential attachment* expands beyond the individual researcher. Kwiek (2021) observed similar prestige-maximizing behavior at the institutional level. When participating in international collaborations, researchers increase their institution's prestige in addition to their personal research prestige (Melguizo and Strober 2007). For this reason, research institutions are increasingly incentivizing international collaboration, especially with other established researchers (Melguizo and Strober 2007). Kwiek (2021) found that elite academic institutions are most likely to collaborate internationally with other elite institutions (e.g., Oxford University in the United Kingdom collaborating with Harvard University in the United States).

There is also evidence of preferential attachment at the national level. Countries seek partnerships with other countries possessing the most scientific capacity; as a result, developing countries tend to be excluded from such activities (Schubert and Braun 1990; Wagner et al. 2001). Network analyses show nine countries that are the most sought-after collaborators: England, Germany, France, Italy, the Netherlands, Switzerland, the United States, Belgium, and Spain (Wagner et al. 2001). Collaboration between countries allows scientific research teams to share equipment costs and tackle more complex research questions (Sauer et al. 2011; Dusdal and Powell 2021). This is reflected in high rates of international collaboration in fields requiring the greatest capital investment, such as astronomy (Gazni et al. 2012). International collaboration is also an important form of diplomacy, allowing countries to build bridges through shared research teams (Sauer et al. 2011).

While there is limited research on DEIA in international S&T collaboration, especially at the institutional level, research has shown women tend to have smaller international collaboration networks (Elsevier 2017). It is unclear to what extent HBCUs, MSIs, and EPSCoR jurisdiction institutions participate in international collaboration. Given the importance of international collaborations at the individual, institutional, and national level, information and research are needed to understand the participation of underrepresented groups in STEM in international S&T collaborations. To address this gap, STPI examined HBCUs, enrollment-based MSIs, and EPSCoR jurisdiction institutions to look into U.S. institutional diversity in international S&T collaboration.

2. Overview of Historically-defined, Enrollment-defined, and Jurisdiction-defined Institutions

MSIs are accredited Institutions of Higher Education (IHEs) with substantial concentrations of minority students (U.S. Department of Education 2023c; Congressional Research Service 2023). There are roughly 700 MSIs in the United States, representing nearly 30 percent of undergraduate students (Espinoza et al. 2019). MSIs create educational

opportunities for students of color that might not otherwise exist, particularly in STEM fields (Espinosa et al. 2019). Appendix A includes a list of all the MSIs and their eligibility criteria in the United States.

There are two main types of MSI: historically-defined and enrollment-defined institutions (Espinosa et al. 2019; U.S. Department of Education 2023a). Most historically-defined MSIs are HBCUs.¹ From the 1800s to mid-1900s, when traditionally White institutions denied access to non-Whites, HBCUs arose as the primary avenue for Black Americans to pursue higher education. Today, HBCUs remain an important pillar of the U.S. higher education system for Black Americans. There are 103 HBCUs in the United States (National Center for Education Statistics n.d.).²

Unlike HBCUs, enrollment-defined MSIs must meet demographic requirements and regularly apply for eligibility designation (Table A-1 in Appendix A; U.S. Department of Education 2023a).³ For example, an institution's undergraduate enrollment must be at least 25% Hispanic to be eligible for determination as a Hispanic-Serving Institution (HSI; Congressional Research Service 2023). An IHE may be able to qualify as multiple enrollment-defined MSI types (Espinosa et al. 2019). A list of MSI types and their eligibility criteria is provided in Appendix A. In contrast to HBCUs, these institutions were not necessarily created with the principal purpose of serving a minority student population.

EPSCoR institutions are jurisdiction-defined as the program aims to promote geographical diversity by providing grants to traditionally underfunded States and Territories (Cooke n.d.; National Science Foundation 2022b). The original motivation for EPSCoR came from a National Science Board analysis highlighting how a handful of States received the majority of Federal research funding (National Science Foundation 2022b). To encourage research capacity building across the country, Congress created the National Science Foundation's (NSF) EPSCoR program (National Science Foundation 2022b). To be eligible for consideration as an EPSCoR jurisdiction, a State or Territory needs to have received less than or equal to 0.75 percent of NSF's total research funding budget over the previous 5 years (National Science Foundation 2022b).⁴ Any accredited

¹ American Indian Tribally Controlled Colleges and Universities (TCCUs) are also historically defined institutions. However, STPI was not able to capture any in its sample. STPI's source data, the National Center for Science and Engineering Statistics' Higher Education Research and Development (HERD) Survey, did not include TCCUs because none met its research and development spending threshold.

² To qualify as an HBCU under the Higher Education Act, an institution must have been established before 1964, have a primary mission of educating Black Americans, and be an accredited institution.

³ Enrollment-defined institutions consist of: Alaska Native and Native Hawaiian-serving institutions (ANNHs), Native American-Serving Nontribal Institutions (NASNTIs), Asian American and Native American Pacific Islander-Serving Institutions (AANAPISIs), Predominantly Black Institutions (PBIs), and HSIs (U.S. Department of Education [ED] 2023a).

⁴ Multiple Federal agencies have EPSCoR programs with different eligibility requirements (Institute of Medicine et al. 2013). For the purposes of this paper, STPI used NSF's program requirements. As of

IHE located within these States and Territories qualifies as an EPSCoR jurisdiction institution.

When compared to other U.S. IHEs, HBCUs, enrollment-defined MSIs, and EPSCoR jurisdiction institutions have historically received fewer opportunities in S&T research. It is therefore important to understand which factors affect their participation in international S&T collaborations by comparing their research output with that of their peer institutions (Mohammadi et al. 2023; Aref et al. 2021; Agesa et al. 2001). Research on HBCU funding shows that HBCUs typically possess smaller endowments and receive less foundation funding per institution than non-HBCUs (Williams and Davis 2019; Clerkin et al. 2023). MSI faculty also tend to have larger teaching loads than non-MSI faculty, which leaves less time to pursue research funding opportunities (Betsey 2007; Aref et al. 2021; Chavela Guerra and Wilson 2021). EPSCoR jurisdictions, even though they encompass half of the 50 U.S. States and 22 percent of the employed workforce, collectively received only 13 percent of NSF Research and Related Activities (R&RA) and Education and Human Resources (EHR) funding in FY2021 (Cooke n.d.). This report provides a first step toward understanding how HBCUs, MSIs, and EPSCoR jurisdiction institutions participate in international S&T collaborations.

2023, there are 28 EPSCoR jurisdictions. These consist of 25 States and 3 U.S. Territories: Alabama, Alaska, Arkansas, Delaware, Guam, Hawaii, Idaho, Iowa, Kansas, Kentucky, Louisiana, Maine, Mississippi, Montana, Nebraska, Nevada, New Hampshire, New Mexico, North Dakota, Oklahoma, Puerto Rico, Rhode Island, South Carolina, South Dakota, Vermont, U.S. Virgin Islands, West Virginia, and Wyoming (National Science Foundation).

2. Bibliometric Analyses

STPI conducted a bibliometric analysis to answer the following research questions in response to recommendation 12 of the 2022 ISTC report:

- Do HBCUs, MSIs, and EPSCoR jurisdiction institutions collaborate internationally to the same degree as their peer institutions, as reflected in co-authored publications?
- Which institutional characteristics of HBCU, MSI, and EPSCoR status institutions and their peer institutions impact the quantity of international S&T collaborations?

This chapter provides an overview of the data and methods for the bibliometric analysis, followed by the results.

A. Data and Methods

There are three main components to the bibliometric analysis: designing the conceptual framework that guides the analysis; creating focal and comparison groups for the HBCUs, enrollment-based MSIs, and EPSCoR jurisdiction institutions; and lastly, conducting the bibliometric data analyses.

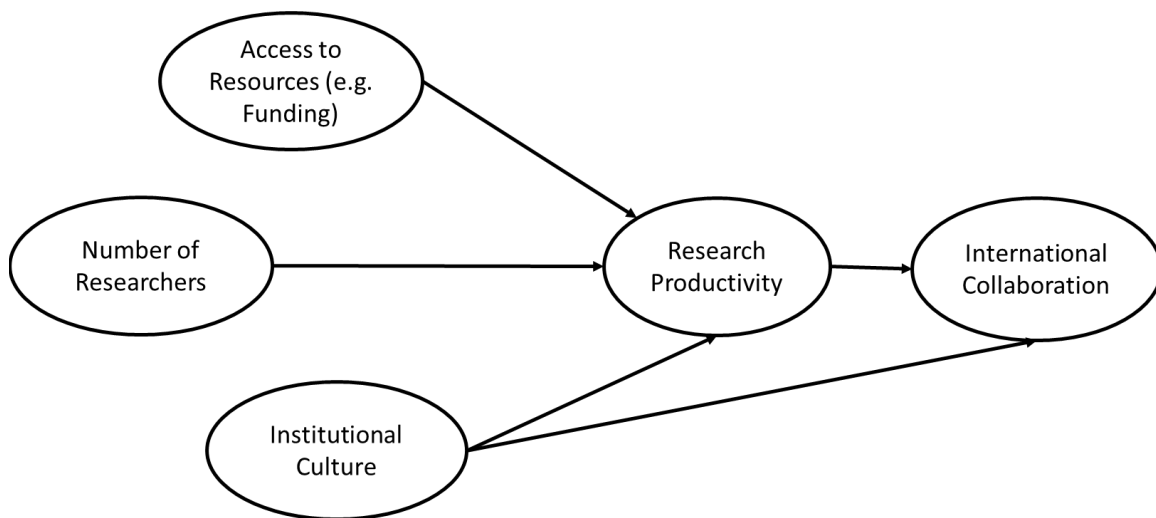
1. Conceptual Framework

STPI hypothesized a set of general factors that likely affect international S&T collaborations at the institutional level. To explain the relationship between these factors and international collaborations, STPI created a conceptual framework to inform the study (Figure 1). The framework grounds STPI's analysis by outlining the assumptions of the analysis.

The unique missions and characteristics of HBCUs, MSIs, and EPSCoR jurisdiction institutions are related to how they conduct and publish research. HBCUs, MSIs, and EPSCoR institutions generally have received less Federal funding and private investment for R&D and thus have lower levels of R&D compared to other U.S. IHEs, which most likely translates to fewer international collaborations. According to the literature, institutions with more researchers and greater resources (e.g., more faculty and higher levels of R&D funding) are able to achieve greater research productivity as measured by higher publication rates (Zhang et al. 2022). International S&T collaborations are most likely a function of an institution's overall research productivity, and thus, international

collaborations are likely to be heavily influenced by number of researchers and amount of resources for research. Thus, an IHE with higher research productivity has a higher likelihood of an international research collaboration than an IHE with lower research productivity. Similarly, an IHE’s research productivity is driven by its access to resources (e.g., R&D funding and research infrastructure) and the number of personnel available. Therefore, the main components in the conceptual framework used to relate institution type and international collaboration are *access to resources*, *number of researchers*, and *research productivity* (Figure 1). Table 1 lists the indicators used to operationalize these components.

There are additional, less quantifiable factors that affect international collaborations, such as the prestige and reputation of the IHE, institutional policies and promotion based on international collaboration, whether the institution has a specific disciplinary focus (e.g., medical schools), and the geographic location of the institution. These factors encompass *institutional culture*. Though it was not feasible to account for all elements that could influence institutional culture in the current study, STPI included the following four major factors: urban-rural classification, funding amounts for specific research disciplines, whether an institution is public or private, and Carnegie Classification⁵ (Table 1; Carnegie Classification of Institutions of Higher Education® 2023).



Note: Table 1 lists the main indicators for each of the components.

Figure 1. Conceptual Framework Showing the Main Components That Influence International Collaborations

⁵ The Carnegie Classification categorizes U.S. universities by their research activity levels.

STPI makes two overarching assumptions with this conceptual framework:

1. IHEs with *more researchers* and *greater access to R&D resources* have greater research productivity, and therefore a higher chance for international collaboration activity, than those that have fewer researchers and less R&D resources.
2. There are *other institutional characteristics*, partly described by an *institution's culture*, that affect research productivity and international collaboration activity.

Using the conceptual framework, STPI operationalized the research questions by identifying variables that serve as quantitative indicators for each of the components (Table 1). Appendix B provides a data dictionary describing these institution-level variables.

Table 1. Indicator Variables for Conceptual Framework

Conceptual Framework Component	Indicator Variable	Data Source
Access to Resources (e.g., funding)	Total R&D expenditures	HERD ^a
Number of Researchers	Number of faculty	IPEDS ^b
	Number of students	IPEDS
Institutional Culture	Public vs. private institution	IPEDS
	Carnegie Classification	Carnegie Classification ^c
	Urban/rural classification	IPEDS
Research Productivity	R&D expenditures by discipline	HERD
	Total number of publications	WoS ^d
International Collaboration	Number of publications with international co-authors	WoS

^a National Center for Science and Engineering Statistics (2022)

^b National Center for Education Statistics (2023)

^c American Council on Education (2023)

^d Clarivate (2023)

2. Focal and Comparison Groups

HBCUs, MSIs, and EPSCoR institutions tend to have lower research productivity and access to resources when compared with the rest of U.S. IHEs. Consequently, comparing HBCUs, MSIs, and EPSCoR institutions against the rest of U.S. IHEs would not elicit differences in international collaboration patterns attributable to an IHE's type (e.g., HBCU, MSI, EPSCoR) due to the inability to decouple the effect of institution type from

factors associated with general resource and productivity discrepancies across U.S. IHEs. To ascertain the effect of institution type on international collaboration while controlling for resource levels, STPI chose to analyze institutions with resource levels comparable to the resource levels of the HBCUs, MSIs, and EPSCoR jurisdiction institutions under study. Specifically, STPI created *comparison conditions* for each *focal group* under study (HBCUs, MSIs, and EPSCoR jurisdiction institutions) by matching each institution within a focal group to a similar institution outside that focal group, thereby creating a *comparison group* (Table 2), based on the matching covariates (Table 3).

Table 2. Focal and Comparison Groups

Focal Group	Comparison Group
HBCUs	Non-HBCUs, but can be a different MSI
Enrollment-based MSIs	Non-MSIs
EPSCoR jurisdiction institutions	Non-EPSCoR jurisdiction institutions

Table 3. Matching Covariates and Their Data Sources

Matching Covariate	Variable Type	Data Source
Total R&D expenditures	Numerical	HERD
Number of full-time faculty	Numerical	IPEDS
Number of students	Numerical	IPEDS
Proportion of expenditure spent on basic research to total R&D expenditure	Numerical	HERD
Proportion of expenditure spent on life sciences research to total R&D expenditure	Numerical	HERD
Institution includes medical school (yes/no)	Categorical (2 categories)	HERD
Public or private institution	Categorical (2 categories)	IPEDS
Carnegie Classification	Categorical (4 categories)	American Council on Education
Geographic locale	Categorical (4 categories)	IPEDS

Among data sources for the matching indicator variables, the National Center for Science and Engineering Statistics' Higher Education Research and Development (HERD) Survey is the most limiting in terms of institution sample size. The survey is an annual

census of 4-year institutions that expend at least \$150,000 in R&D in a given academic year.⁶ The HERD dataset limits the institutions for analysis to the ones that meet this requirement, which are likely the institutions with the greatest international collaboration activity according to the conceptual framework. STPI gathered data on institutions that responded every year to the HERD Survey from 2010 to 2021, which gave a sample of 504 institutions. This list of institutions contained 41 HBCUs, 92 MSIs, and 110 EPSCoR jurisdiction institutions, which formed the samples for the focal groups.⁷

To gather information on institutional characteristics beyond funding, STPI appended data from the National Center for Education Statistics' Integrated Postsecondary Education Data System (IPEDS) and the MSI data project to the HERD dataset using IPEDS ID. IPEDS was used for descriptive characteristics of the IHEs (geographic locale, private/public, and institution size), and the MSI data project was used to flag the IHEs by type of MSI and provided Carnegie classification information.⁸

To develop the comparison conditions from the list of 504 institutions, STPI used covariate matching via the MatchIt package in R (Ho et al. 2011; The R Foundation 2023). To create the comparison conditions, comparison groups were identified by pairing each focal group IHE with its most similar IHE outside the focal group. Matching criteria included the median-aggregated covariates outlined in Table 3 while Euclidean distance was used as a measure of similarity. All institutions that were not paired with a focal group institution were removed from the analysis for that comparison condition. After completing the matching process, the quality of the matches was assessed by computing the difference between the matched focal and comparison groups in terms of standardized means, variance ratios, and visual diagnostics (kernel density and empirical quantile-quantile plots) for each covariate in order to determine whether the focal and comparison groups were balanced (Stuart et al. 2013; Ho et al. 2011; Austin 2009). The list of HBCUs, MSIs, and EPSCoR jurisdiction institutions along with their matching institutions is included in Appendix C.

⁶ The HERD Survey: <https://www.nsf.gov/statistics/srvyherd-legacy/#micro&profiles&tools&tabs-1&sd>

⁷ MSI designations are given on a yearly basis. The MSI data project did not have designations prior to 2017, so for consistency, the 2021 MSI designation was applied to each year for a given institution. While HBCU status does not vary greatly on an annual basis, some of the other MSI populations (i.e., HSIs) have changed in the research timeframe. EPSCoR status was also determined by the FY2021 designations of EPSCoR States and Territories.

⁸ Carnegie Classifications of Institutions of Higher Education: <https://carnegieclassifications.acenet.edu/>

3. Bibliometric Analyses

Publication metadata and citation data were gathered from Clarivate’s Web of Science (WoS) Core Collection database.⁹ To filter for S&T collaborations, STPI only examined publications indexed as “Science and Technology” or “Social Sciences” by Clarivate.¹⁰ STPI gathered publication metadata with at least one author affiliated with a focal or comparison IHE. To filter for international collaborations, STPI identified publications with at least one author with an institutional affiliation from a non-U.S. country.¹¹ The count of international publications, as well as the proportion of international publications to total publications, were calculated for each focal and comparison IHE.

STPI used generalized linear mixed-effects models (GLMM)¹² to test for differences in international publication counts and proportion of international publications between focal and comparison groups for the HBCU, MSI, and EPSCoR comparison conditions, with each condition (HBCU and comparison; MSI and comparison; EPSCoR and comparison) modeled separately. For each comparison, the outcomes of the models were: count of international publications and proportion of international publications, with IHE type as the predictor of interest in both cases. Given the data for this study, each IHE was observed for a 5-year span (2017–2021), the intercept was allowed to vary randomly across IHEs, while the effect of institution type on the outcome was fixed across years. The models were fit to the data using the lme4 package in R (Bates et al. 2015; The R Foundation 2023).

B. Results

1. HBCUs

A total of 41 HBCUs and 41 non-HBCU matched IHEs were examined in this bibliometric analysis. Between 2017 and 2021, the 41 non-HBCUs produced 12,493

⁹ The Web of Science Core Collection contains records of publication and citation for academic journal articles, conference proceedings, and books with coverage from 1900 to present. The Core Collection database is an aggregation of seven citation indexes covering the most notable and significant journals in research in science and technology, social sciences, and arts and humanities fields.

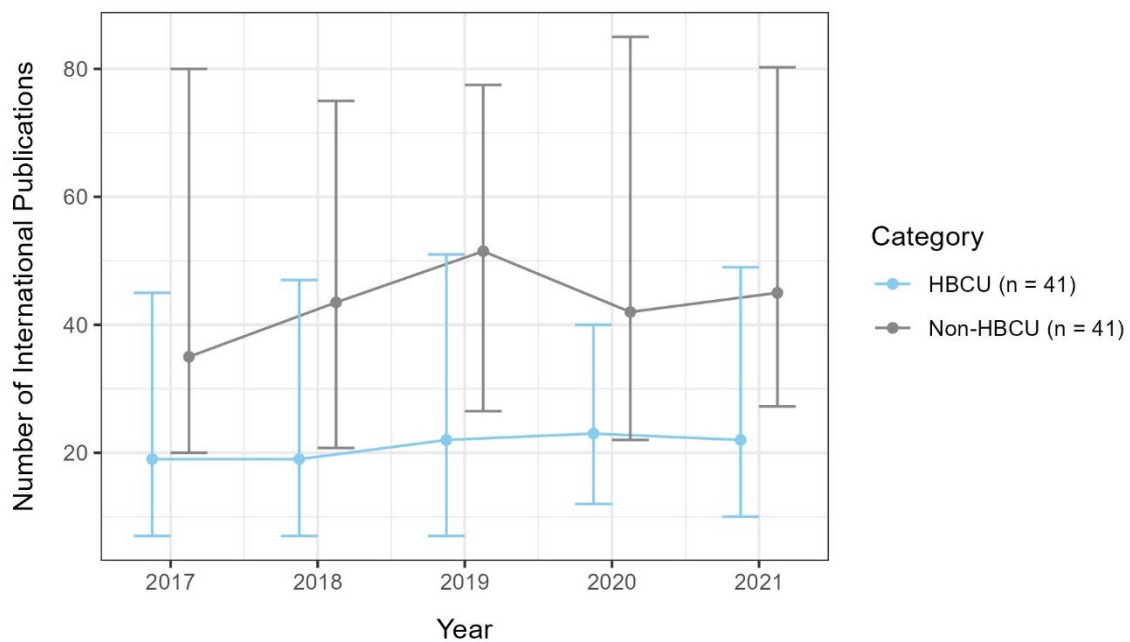
¹⁰ This eliminated publications classified as “Arts and Humanities,” which comprised less than 10% of the publications in the Core Collection.

¹¹ If an author listed both a U.S. and non-U.S. affiliation on a single publication, the publication is still counted as an international collaboration for this study.

¹² The response distribution for the international publication counts was assumed to follow a Poisson distribution, and the predictor variables were related to the response distribution using a log transformation. The response distribution for proportion of international publications was assumed to follow a binomial distribution and the predictor variables were related to the response distribution using a logit transformation. The models were estimated using maximum likelihood estimation via Laplace approximation (Bates 2008).

publications with international co-authors and the 41 HBCUs produced 7,542 publications with international co-authors. The total number of international publications per IHE for the 5-year time span ranged from 11 to 1,233 for HBCUs and 22 to 1,803 for non-HBCUs. HBCUs had a lower annual institutional median number of international publications (21) compared to non-HBCUs in the comparison group (43.5). The difference between the number of publications between HBCU and non-HBCU institutions was statistically significant ($\chi^2_1 = 6.07, p < 0.05$).

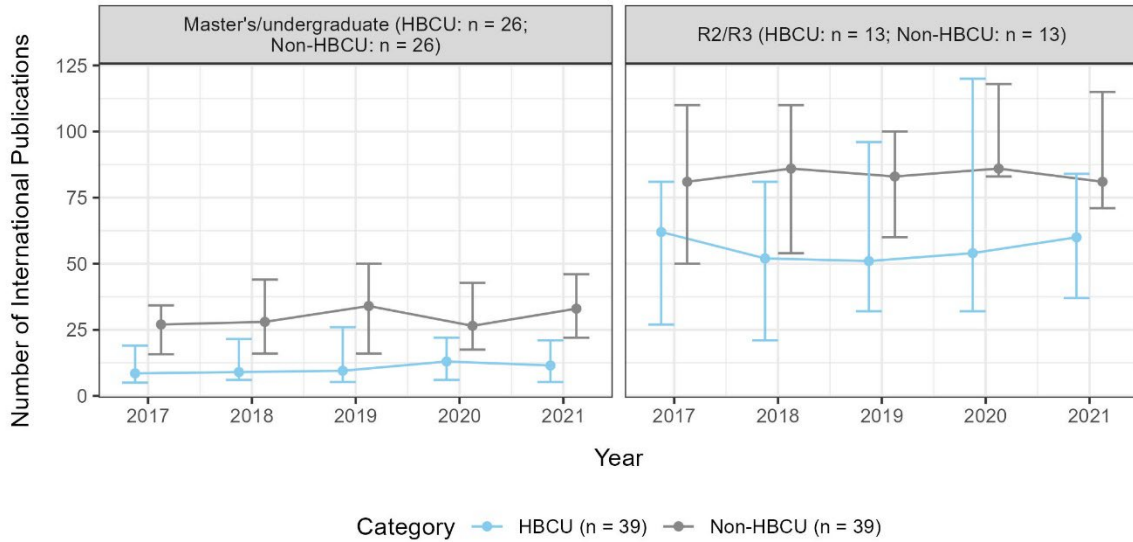
The median number of international publications for HBCUs and non-HBCUs from 2017 to 2021 shows the statistically significant difference in the distribution of international publications between the two groups of institutions (Figure 2).



Note: The dot represents the median of the institutions in the group. The lower bar represents the 25th percentile while the upper bar represents the 75th percentile.

Figure 2. Median Number of International Publications for HBCUs and Their Non-HBCU Comparison Group

The difference in the number of international publications between HBCUs and non-HBCUs holds across Carnegie Classification categories (Figure 3). The annual institutional median for the R2/R3 HBCUs is 56, but the annual institutional median for R2/R3 non-HBCUs is 86. The annual institutional median for master’s/undergraduate HBCUs is 10.5, but the annual institutional median for master’s/undergraduate non-HBCUs is 28.

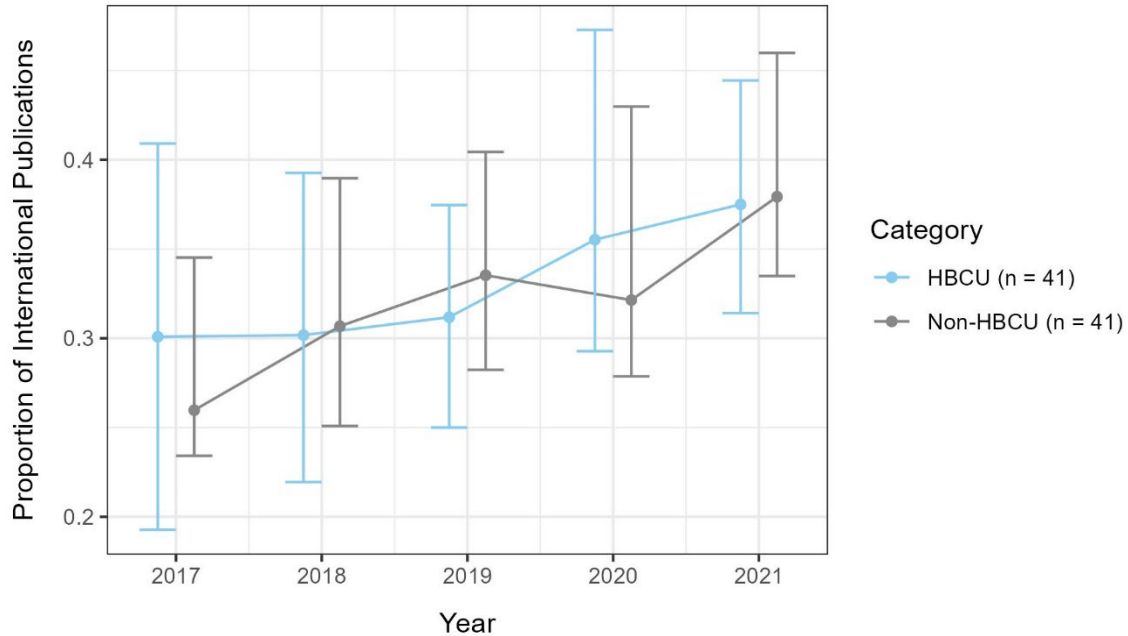


Notes: Two HBCUs and their non-HBCU matched IHEs were classified as medical institutions and not included in the figure, because the sample size was so small.

The dot represents the median of the institutions in the group. The lower bar represents the 25th percentile while the upper bar represents the 75th percentile.

Figure 3. Median Number of International Publications for HBCUs and Their Non-HBCU Comparison Group by Carnegie Classification

Regarding the number of international publications relative to an IHE's total publications, results from the GLMM showed that the proportion of international publications did not statistically differ between HBCU and non-HBCUs ($\chi^2_1 = 0.09, p = 0.77$). However, both HBCUs and non-HBCUs exhibited an increase in proportion of international publications from 2017 to 2021, which was found to be significant ($\chi^2_1 = 118.64, p < 0.05$). The median proportion of international publications for HBCUs started at 0.30 in 2017 and grew to 0.38 in 2021 (Figure 4). The median proportion of international publications for non-HBCUs started at 0.26 in 2017 and grew to 0.38 in 2021.

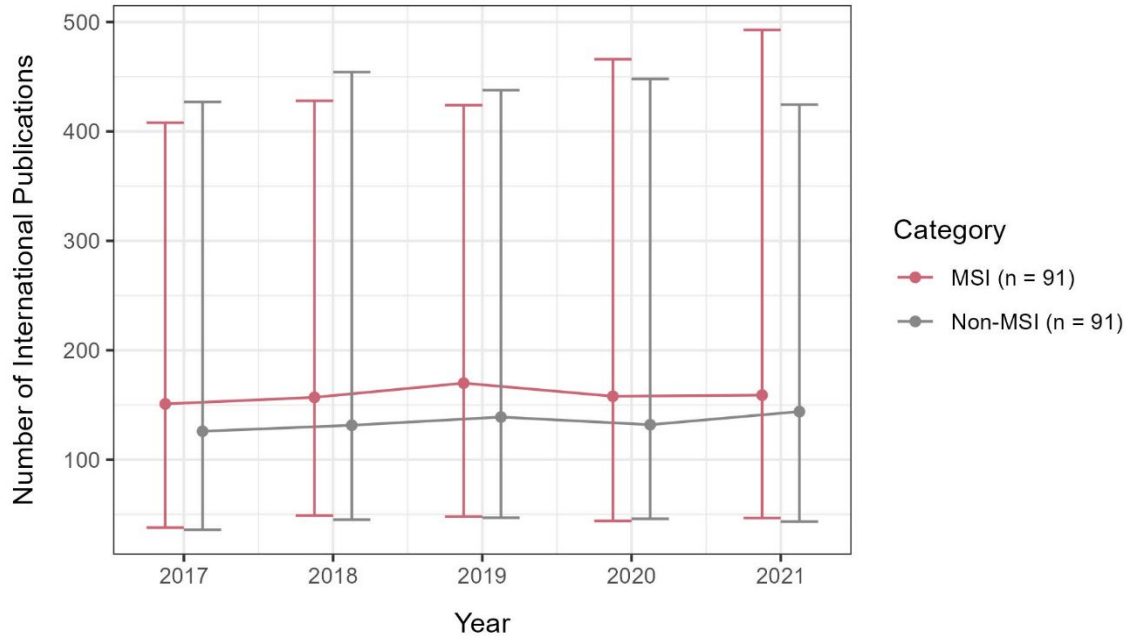


Note: The dot represents the median of the institutions in the group. The lower bar represents the 25th percentile while the upper bar represents the 75th percentile.

Figure 4. Median Proportion of International Publications of an Institution’s Total Publications at HBCUs and Non-HBCUs

2. MSIs

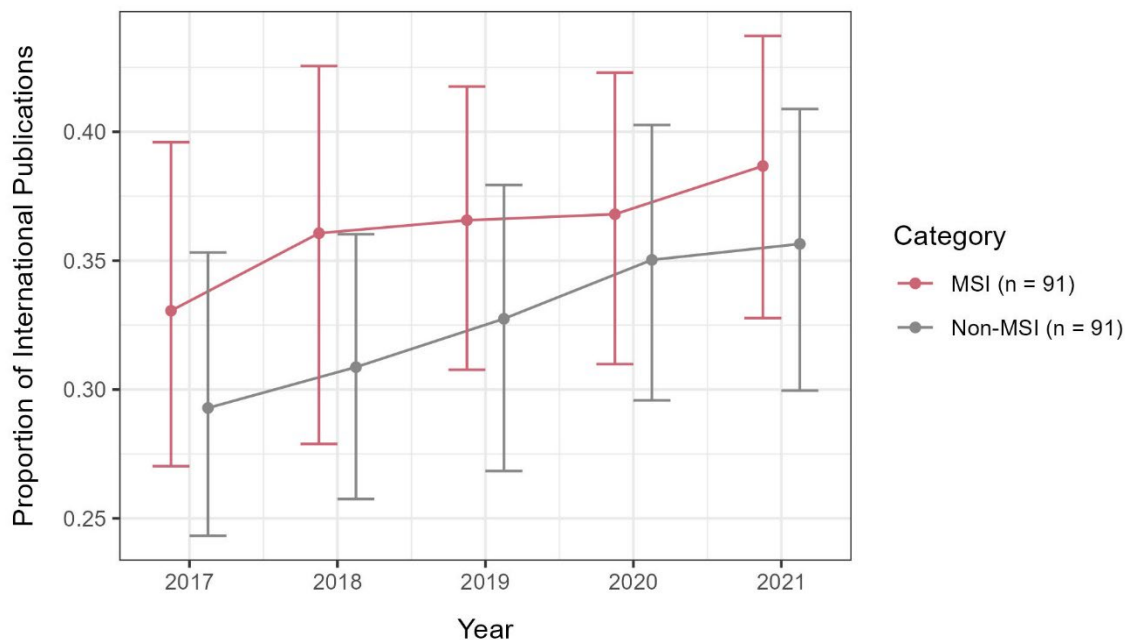
A total of 91 MSI institutions and 91 non-MSI matched institutions were examined. Between 2017 and 2021, the 91 MSIs produced 198,913 publications with international co-authors and the 91 non-MSIs produced 190,413 publications with international co-authors. The total number of international publications per IHE for this time span ranged from 19 to 18,547 for MSIs and 37 to 23,020 for non-MSIs. MSIs had a slightly higher annual median number of international publications across the 5 years (158) compared to the non-MSI comparison group (134), although the difference was not found to be significant ($\chi^2_1 = 0.19, p = 0.66$) (Figure 5).



Note: The dot represents the median of the institutions in the group. The lower bar represents the 25th percentile while the upper bar represents the 75th percentile.

Figure 5. Median Number of International Publications for MSIs and Their Non-MSI Comparison Group

Results from the GLMM showed that the proportion of international publications increased significantly for both MSI and non-MSIs from 2017 to 2021 ($\chi^2_1 = 572.69, p < 0.05$). MSIs also had a significantly higher proportion of international publications compared to the non-MSIs during this time span ($\chi^2_1 = 5.42, p < 0.05$). The median proportion of international publications for MSIs started at 0.33 in 2017 and grew to 0.39 in 2021 (Figure 6). The median proportion of international publications for non-HBCUs started at 0.29 in 2017 and grew to 0.36 in 2021.

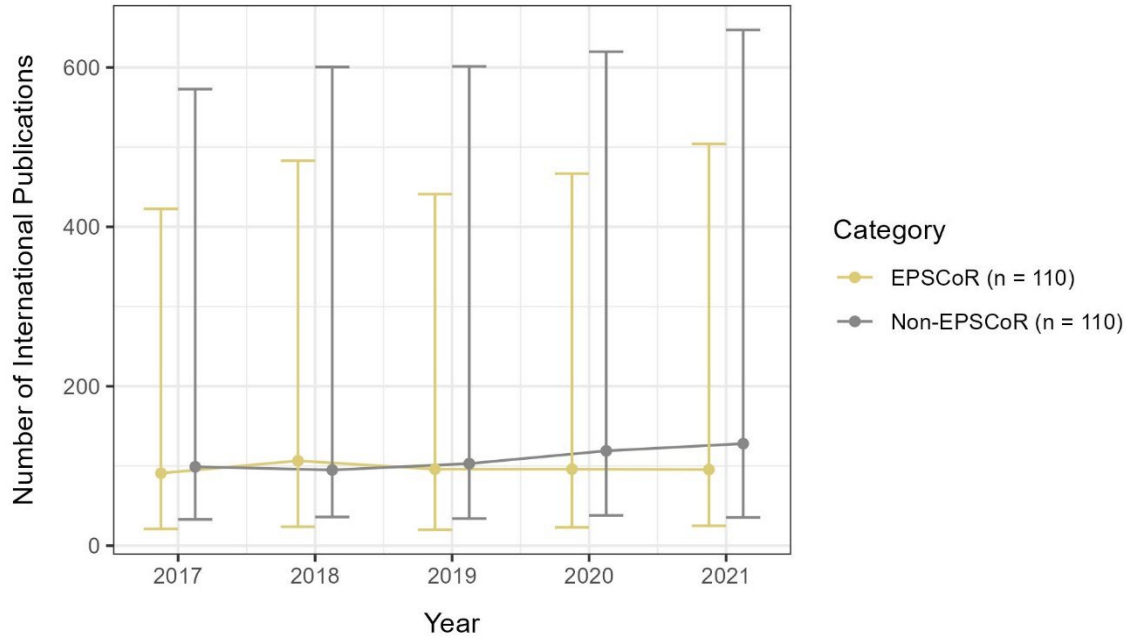


Note: The dot represents the median of the institutions in the group. The lower bar represents the 25th percentile while the upper bar represents the 75th percentile.

Figure 6. Median Proportion of International Publications of an Institution's Total Publications at MSIs and Non-MSIs

3. EPSCoR Jurisdiction Institutions

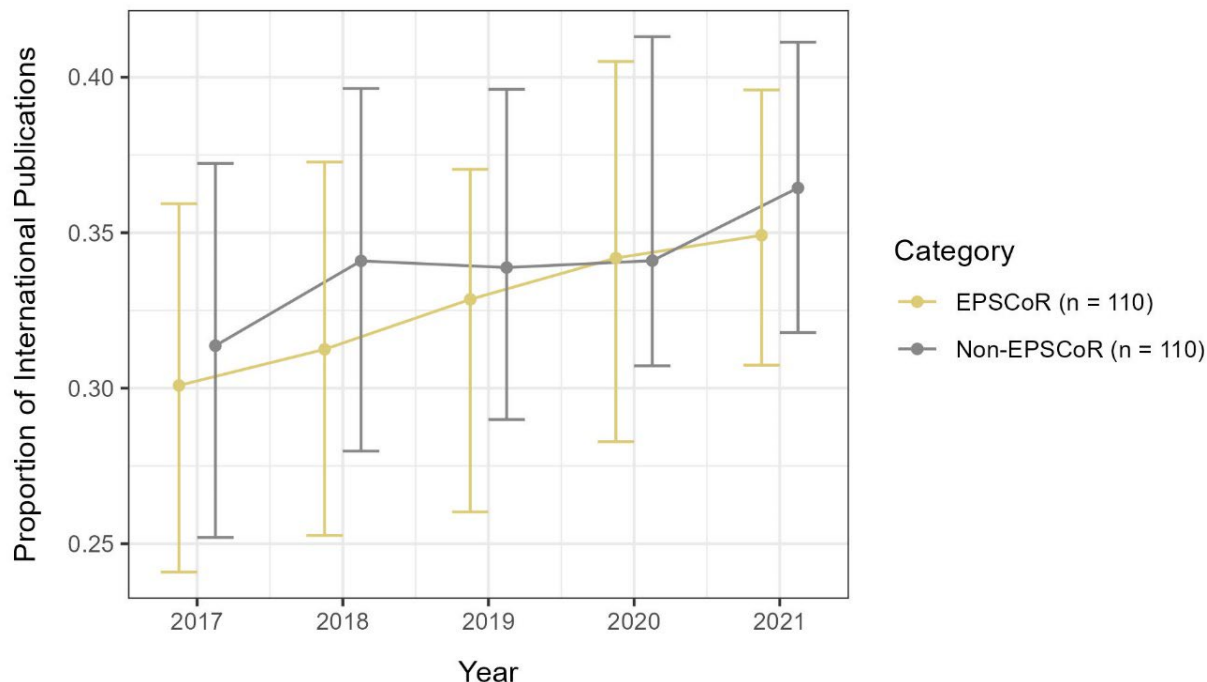
A total of 110 EPSCoR institutions and 110 non-EPSCoR matched institutions were examined in this bibliometric analysis. Between 2017 and 2021, the 110 EPSCoR institutions produced 169,150 publications with international co-authors and the 110 non-EPSCoR institutions produced 203,660 publications with international co-authors. The total number of international publications per IHE for this time span ranged from 11 to 8,889 for EPSCoR institutions and 7 to 11,444 for non-EPSCoR institutions. EPSCoR institutions had a slightly smaller annual number of international publications across the 5 years (97) compared to the non-EPSCoR comparison group (112), although the difference was not found to be significant ($\chi^2_1 = 1.62, p = 0.20$) (Figure 7).



Note: The dot represents the median of the institutions in the group. The lower bar represents the 25th percentile while the upper bar represents the 75th percentile.

Figure 7. Median Number of International Publications for EPSCoR Institutions and Their Non-EPSCoR Comparison Group

Lastly, although results from the GLMM showed that the proportion of international publications did not differ between EPSCoR and non-EPSCoR institutions ($\chi^2_1 = 0.76$, $p = 0.39$), the increase in proportion of international publications from 2017 to 2021 was found to be significant ($\chi^2_1 = 464.91$, $p < 0.05$). The median proportion of international publications for EPSCoR institutions started at 0.30 in 2017 and grew to 0.35 in 2021 (Figure 8). The median proportion of international publications for non-EPSCoR institutions started at 0.31 in 2017 and grew to 0.35 in 2021.



Note: The dot represents the median of the institutions in the group. The lower bar represents the 25th percentile while the upper bar represents the 75th percentile.

Figure 8. Median Proportion of International Publications of an Institution’s Total Publications at EPSCoR and Non-EPSCoR Institutions

C. Data Caveats and Limitations

There is a non-trivial amount of missing data in all the sources used, especially in the HERD and IPEDS datasets. At this time, because there were no missing observations in the outcome variable (i.e., publication count), STPI removed missing data from the analyses using listwise deletion. Although the HERD dataset provides complete total R&D expenditure data, the expenditure data by discipline is incomplete. Only expenditures for basic research and life science research (<2% missing) were used for the matching process. For the IPEDS data, only <1% of the data were missing for the number of students and number of faculty. Other relevant variables, such as the financial endowment of the university, were not considered due to high proportions of missing data. For example, an IHE’s reported endowment is a good indicator for an IHE’s financial resources and may be causally associated with research productivity or international collaboration; however, less than half of the IHEs reported their endowment size.

There was also missing data in the WoS dataset for certain IHEs. Other issues with name disambiguation arose when IHE affiliations did not publish in a consistent manner across researchers and publishers for a given IHE or when an IHE’s name changed over time. Moreover, an author’s institutional affiliation can vary over time, and the bibliometric metadata for IHEs is captured at the author level (for each publication), which was an issue

for this study considering the analysis was done at the institution level. Consequently, 8 institutions from the list of 504 were removed from analysis before matching, because STPI could not attribute any publications to the institution based on the metadata provided in WoS. To match institutional data across the different sources, STPI manually matched certain IHEs from HERD and IPEDS to WoS. Furthermore, the WoS Core Collection only captures the most notable scientific journals and potentially does not cover lesser-known journals. There may be a skew that underrepresented minorities, especially those affiliated with HBCUs, publish more in journals that are not indexed by the WoS Core Collection. However, this is only an assumption, and there needs to be a more systematic analysis of the WoS Core Collection to confirm this claim.

Lastly, the results only capture the most well-funded and research-active HBCUs, MSIs, and EPSCoR jurisdiction institutions. They reflect a limited sample size of IHEs and a limited time frame of bibliometric data. Due to challenges in data availability and timing, the timeframe was limited from 2017 to 2021. Using the HERD data limited the institutions to 4-year universities with substantial R&D expenditures. Thus, the results from this study cannot be generalized for all HBCUs, MSIs, and EPSCoR jurisdiction institutions, as many do not meet the criteria to be included in HERD. For example, there are 103 HBCUs in the Nation, but only 41 were included in the bibliometric analyses. All MSIs examined in this study were either HSIs or Asian American and Native American Pacific Islander-Serving Institutions (AANAPISIs). Other MSIs, such as Tribally Controlled Colleges and Universities (TCCUs) and Native American-Serving Nontribal Institutions (NASNTIs), were not examined, because they did not meet the threshold to be included in the HERD Survey. However, institutions that do not meet the HERD Survey criteria—those that do not expend at least \$150,000 in R&D—are unlikely to publish articles in academic journals given the expense of academic research, much less publish articles with international co-authors.

STPI only had access to 5 years of bibliometric data from WoS at this time, from 2017 to 2021. This is a limited time frame, especially considering the impact of the global COVID-19 pandemic on academic researchers in 2020 and 2021. While the pandemic most likely affected research and international collaborations at all IHEs, it may have affected HBCUs, MSIs, and EPSCoR jurisdiction institutions disproportionately. Additional years of data would need to be included in a subsequent analysis in order to further corroborate the preliminary findings of this study.

3. Discussion and Conclusion

A. Interpretation of Findings

By comparing international S&T collaborations—as reflected in co-authored publications—at HBCUs, other MSIs, and EPSCoR jurisdiction institutions to appropriate comparison IHEs, STPI found:

- HBCUs had statistically significantly fewer international publications compared to IHEs with similar R&D funding and numbers of researchers in 2017 through 2021. However, HBCUs and their non-HBCU peer institutions had a statistically comparable proportion of international publications.
- MSIs had slightly more international publications compared to non-MSI peer institutions, although the difference was not statistically significant. However, MSIs had a statistically significant higher proportion of international publications compared to non-MSIs.
- EPSCoR jurisdiction institutions had a statistically similar number and proportion of international publications compared to peer IHEs in non-EPSCoR jurisdictions.

The bibliometric analyses, supported by academic literature, suggest that different institutional characteristics at HBCUs, MSIs, and EPSCoR jurisdiction institutions impact their international collaborations, detailed below.

1. HBCUs

There is a statistically significant difference in the total number of international publications between the focal HBCU group of IHEs and the comparison group (Figure 2). Yet the proportion of international publications is statistically similar between HBCUs and non-HBCUs (Figure 3), indicating that the difference in total international publications stems from a difference in total publications and overall research productivity at HBCUs.

Institutional culture and incentives play a substantial role in research productivity, which can explain the difference in number of international publications between HBCUs and non-HBCUs (Agesa et al. 2001; Betsey 2007; Way et al. 2019; Escobar et al. 2021). Agesa et al. (2001) found that HBCUs produce significantly fewer research publications relative to non-HBCUs within the economics discipline. Agesa and colleagues reported that HBCU researchers are generally “swimming upstream” with heavier teaching loads,

greater administrative responsibilities, extensive office hours, and limited funds to attend academic conferences compared to non-HBCU researchers (Agesa et al. 2001).

Faculty-time allocation at HBCUs seems to be a major factor of institutional culture that impacts research productivity and international collaborations, especially considering that HBCUs provide a much greater focus on teaching and educating rather than on research. University faculty split their time on research, teaching, and community engagement, but HBCU faculty spend more time on teaching (Escobar et al. 2021), resulting in less time for research and producing journal publications (Betsey 2007).

In addition, there are unique factors at HBCUs that impact their ability to participate in international collaborations beyond research productivity. Due to a system of preferential attachment in international collaborations, HBCUs may be at a disadvantage when seeking collaborators. The prestige and reputation of collaborators and collaborating IHEs matter for international S&T collaborations, as researchers usually seek high-performing collaborators from high-performing IHEs (Wagner and Leydesdorff 2005b; Kwiek 2021). Because HBCUs do not fit into traditional forms of prestige and elitism within higher education and face a legacy of historical exclusion from S&T opportunities (Jones 2013), HBCUs face additional barriers to international collaborations compared with other U.S. IHEs.

Furthermore, the indicator used for access to resources—total R&D expenditures—does not fully capture differences in resources between HBCUs and non-HBCUs. HBCUs tend to receive less State funding, possess smaller endowments, and receive less foundation funding than non-HBCUs (Escobar et al. 2021; U.S. Department of Education 2023b; Williams and Davis 2019; Clerkin et al. 2023). These resource constraints inhibit international collaborations by burdening researchers with fewer funding opportunities to attend conferences, smaller international collaboration networks, and fewer colleagues with whom they can share the costs of international research (Hogan et al. 2010).

These institutional culture factors are not fully captured in the bibliometric model because of the lack of available quantitative data. However, the impact of these factors should be investigated further with an emphasis on uncovering why HBCUs may not participate in international collaborations at similar levels as peer non-HBCU institutions.

Follow-on studies are required to understand the nature of HBCU international collaborations and if they differ from international collaborations with non-HBCUs. Because HBCUs have a specific mission that is more service-focused and teaching-oriented, they may be collaborating in different academic disciplines than their non-HBCU counterparts or in different countries that non-HBCUs are overlooking. Furthermore, much of the international collaboration efforts at HBCUs may not be reflected in academic publications. For example, Morgan University states in its 2022–2032 Strategic Goals that it plans to “leverage its ongoing presence in West Africa to develop effective and replicable

models of excellence in international development and responsive, market-based educational service delivery in Latin America and the Caribbean nations” (Morgan State University 2022). Xavier University partnered with the University of Manchester to “facilitate collaborative research and teaching partnerships encouraging faculty and student exchanges, joint research projects, and Global Classrooms initiatives” (Xavier University 2023). Such international collaboration and global expansion efforts may not be published in an academic journal.

These two examples demonstrate how HBCUs are engaging in international collaboration efforts and provide a different type of international collaboration opportunity outside of traditional research productivity.

2. MSIs and EPSCoR Jurisdiction Institutions

Geographic location could be a factor in why MSIs have more international collaborations than peer non-MSIs. Although a geographic locale indicator was included for the IHE matching, the indicator only noted whether the IHE was located in an urban or non-urban region. Hoekman et al. (2010), examining the spatial patterns of scientific collaboration within Europe, found that physical distance along with linguistic and cultural barriers affect collaboration and co-publication activities. This finding seems particularly pertinent for MSIs, as the MSIs captured in this study are HSIs and AANAPISIs, which are concentrated in border States such as California and Texas. These States have larger immigrant populations, allowing their institutions to achieve HSI and AANAPISI status, which likely facilitates collaboration with countries possessing similar linguistic and cultural backgrounds (Luukkonen et al. 1992; Hoekman et al. 2010; Yao 2021). Moreover, these States are physically closer to other countries, decreasing the travel time and other distance barriers for international S&T collaboration. Thus, MSIs have better opportunities for international collaborations, especially with nearby countries and countries that are represented in their immigrant populations. Although this study does not provide a country-level analysis, a relatively simple follow-on analysis would be to examine the countries of institutions that MSI researchers are collaborating with. Such follow-on analysis could also use the same dataset developed for this report.

Certain EPSCoR jurisdiction institutions may also be impacted by this geographic location factor in the opposite manner, which needs to be explored further. While some EPSCoR jurisdictions are located near an international border (e.g., Nevada and Alaska), most are land-locked States situated in the middle of the United States. The location of these EPSCoR jurisdiction institutions may pose a physical barrier to international S&T collaboration, where the higher cost of international travel is a constraint on their collaboration opportunities. Given the fact that EPSCoR jurisdictions were designated due to differences in R&D funding, EPSCoR jurisdiction institutions may have smaller budgets

to travel to international conferences, build international networks, and produce publications with international co-authors.

3. Growth in International Collaborations

The only common trend among all the focal and comparison groups is the increase in proportion of international publications over time. The consistency and statistical significance of this finding demonstrates that international collaborations are increasing in S&T research, even amidst a global pandemic. This finding aligns with academic literature asserting that scientific research is becoming more international in nature facilitated through globalization (Gazni et al. 2012; Coccia and Wang 2016; Wagner et al. 2017). It seems that HBCUs, MSIs, and EPSCoR jurisdiction institutions have the same motivations for international S&T collaboration as other IHEs—to share the costs of science and tackle more complex research questions, to increase the visibility of their research, and connect to a large scientific network (Sauer et al. 2011; Dusdal and Powell 2021). Interestingly, the results do not show a dip in international collaborations in 2020 or 2021 when the COVID-19 pandemic affected global travel and interactions. Earlier articles have documented a dip in international collaboration during the same time period (Liu et al. 2020; Cai et al. 2021). These results indicate that all U.S. IHEs benefit from international collaborations with the trend towards “big science,” where large-scale projects with bigger research teams and budgets dominate. IHEs and individual-level researchers who do not participate in international collaborations may risk being left behind in the scientific community.

B. Further Considerations

In response to Recommendation 12 of the 2022 ISTC Report, this study provides preliminary findings for how HBCUs, MSIs, and EPSCoR jurisdiction institutions participate in international S&T collaborations compared to peer IHEs. Other factors that should be considered include:

- The differences in academic discipline on international collaboration at HBCUs, MSIs, and EPSCoR jurisdiction institutions;
- The countries and international institutions with which HBCUs, MSIs, and EPSCoR jurisdiction institutions are collaborating; and
- The quantity of domestic collaborations and the collaborating institutions at HBCUs, MSIs, and EPSCoR jurisdiction institutions.

HBCUs, MSIs, and EPSCoR jurisdiction institutions may exhibit differences in international collaboration based on academic discipline. This is especially true for HBCUs, which are more service-focused and thus may be collaborating and publishing in different academic disciplines compared to non-HBCUs. The same question applies for countries of international collaboration; HBCUs, MSIs, and EPSCoR jurisdiction

institutions may be collaborating with countries and institutions that their counterparts are overlooking, especially at HBCUs and MSIs where there are large diaspora populations.

Furthermore, the career accelerator component of international S&T collaborations for researchers from underrepresented groups is yet to be examined. One method of addressing this question is to investigate the citations of all the international publications identified in this study, which WoS data can facilitate. Citations are a key criterion for academic promotion (Khor and Yu 2016; Kwiek 2021), and international collaborations usually boost citation rates, especially for countries with the most limited research capacity (Potter et al. 2020; Dusdal and Powell 2021).

C. Conclusion

The 2022 ISTC Report discusses the gap in understanding the participation of researchers from underrepresented groups in STEM in international collaborations and recommends exploring research on how international S&T collaborations at HBCUs, MSIs, and EPSCoR jurisdiction institutions compares to appropriate peer IHEs. This report provides the first step to understanding how HBCUs, MSIs, and EPSCoR jurisdiction institutions participate in international S&T collaborations by looking at the number and proportion of publications with international co-authors. The results indicate that HBCUs produce fewer international publications than their peer non-HBCU institutions, but the proportion of published HBCU research that includes at least one international collaborator is comparable to non-HBCU institutions. These findings suggest that more research is needed to better understand the institutional factors at HBCUs and the barriers they face collaborating internationally.

Appendix A.

Minority-Serving Institution Categories and Eligibility Requirements

Table A-1. MSI Categories, Acronyms, and Eligibility Requirements

MSI Category	Acronym	Eligibility Criteria
Tribally Controlled Colleges and Universities	TCCU	Institutions are controlled, sanctioned, or chartered by an American Indian tribe or tribes. The majority of enrolled students must be American Indian tribe members or biological children of American Indian tribe members (Congressional Research Service 2023).
Alaska Native and Native Hawaiian-Serving Institutions	ANNH	Alaska Native-serving institution: at least 20% of undergraduate students are Alaska Natives Native Hawaiian-serving institutions: a least 10% of undergraduate students are Native Hawaiian (U.S. Department of Education 2023h)
Native American-Serving, Nontribal Institutions	NASNTI	At least 10% of enrolled undergraduates are Native American (U.S. Department of Education 2023f)
Asian American and Native American Pacific Islander-Serving Institutions	AANAPISI	At least 10% of enrolled undergraduate students are Asian American and Native American Pacific Islander (U.S. Department of Education 2023d)
Historically Black Colleges and Universities	HBCU	Established before 1964, have the principal mission of educating Black Americans, and are accredited institutions (U.S. Department of Education 2023e)
Predominantly Black Institutions	PBI	At least 1,000 undergraduate students are enrolled, of which at least 40% are Black American students. At least 50% of undergraduate students are low-income or first generation college students, and at least 50% of undergraduate students are enrolled in bachelor's or associate's degree programs (U.S. Department of Education 2023g)
Hispanic-Serving Institutions	HSI	At least 25% of full-time undergraduate students are Hispanic (U.S. Department of Education 2023i)

Appendix B. Institution Data Dictionary

Table B-1. Institution Data Variables and Descriptions

Variable Name	Data Source	Description
Inst_name_long	IPEDS	Official name of institution
lpeds_unitid_filled	IPEDS, HERD, MSI data project	Unique IPEDS ID
Inst_control	IPEDS	Public or private control of institution
Med_sch_flag	HERD	Flag for if the institution has a med school
Locale	Adapted from IPEDS	Whether the location is located in a city or not
Hbcu_flag	IPEDS	Flag for if the institution is an HBCU
MSI_flag	Adapted from MSI data project	Flag for if the institution is registered as an MSI
EPSCoR_flag	Adapted from HERD	Flag for if the institution is in an EPSCoR jurisdiction
Total_student_count	IPEDS	Total student enrollment counts for a 12-month period
Undergraduate	IPEDS	Undergraduate student enrollment counts for a 12-month period
Graduate	IPEDS	Graduate student enrollment counts for a 12-month period
Total_faculty_count	IPEDS	Number of professional staff
Total_funding	HERD	Total R&D expenditures reported
Basic_funding	HERD	R&D expenditures for experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view

Variable Name	Data Source	Description
Physical_funding	Adapted from HERD	R&D expenditures for general sciences
Social_funding	Adapted from HERD	R&D expenditures for social sciences
Life_funding	Adapted from HERD	R&D expenditures for life sciences
Intl_publications	Calculated from WoS	Number of publications with at least one affiliation matching a focal or comparison institution and one non-US affiliation
Total_publications	Calculated from WoS	Number of publications with at least one affiliation matching a focal or comparison institution
Carnegie Classification	Adapted from the Carnegie Classification of Institutions of Higher Education	Categorizes universities by their research activity where R1, R2, and R3 universities provide doctoral degrees with varying levels of research activity (R1 has the highest level of research activity). Master's and undergraduate universities provide the respective degrees.

Appendix C.

List of HBCUs, MSIs, EPSCoR Jurisdiction Institutions, and Their Matching Institutions

HBCUs

HBCU	Non-HBCU
Alabama A&M University	United States Military Academy
Alabama State University	Rutgers, The State University of New Jersey, Camden
Tuskegee University	Bryn Mawr College
University of Arkansas Pine Bluff	University of Guam
Delaware State University	New Mexico Institute of Mining and Technology
University of the District of Columbia	University of North Carolina at Asheville
Howard University	Mercer University
Florida Agricultural and Mechanical University	University of California, Merced
Albany State University	Pittsburg State University
Clark Atlanta University	Clark University
Fort Valley State University	Sul Ross State University
Morehouse College	Franklin & Marshall College
Morehouse School of Medicine	Albany Medical College
Savannah State University	Christopher Newport University
Spelman College	Occidental College
Kentucky State University	University of Washington, Bothell
Dillard University	Pomona College
Southern University and A&M College, Baton Rouge	University of Louisiana at Monroe
Xavier University of Louisiana	Wesleyan University
University of Maryland Eastern Shore	University of Hawaii at Hilo
Morgan State University	University of New Orleans
Alcorn State University	Montana Tech of University of Montana
Jackson State University	Texas A&M University-Kingsville
Tougaloo College	Harvey Mudd College
Lincoln University, Jefferson City	University of Puerto Rico at Cayey
North Carolina Agricultural and Technical State University	Texas A&M University-Corpus Christi
North Carolina Central University	Humboldt State University

HBCU	Non-HBCU
Central State University	University of Alaska Southeast
Langston University	Salisbury University
Claflin University	Union College, Schenectady
South Carolina State University	University of Illinois at Springfield
Fisk University	Haverford College
Meharry Medical College	Rosalind Franklin University of Medicine and Science
Tennessee State University	Tennessee Technological University
Prairie View A&M University	Idaho State University
Texas Southern University	University of Central Arkansas
Hampton University	Clarkson University
Norfolk State University	California State University, Monterey Bay
Virginia State University	University of Michigan, Dearborn
West Virginia State University	University of Washington, Tacoma
University of the Virgin Islands	Texas A&M International University

MSIs

MSI	Non-MSI
University of Alaska Fairbanks	University of Vermont
University of Alaska Southeast	Savannah State University
University of Arizona, The	Michigan State University
Northern Arizona University	Indiana University-Purdue University, Indianapolis, IUPUI
California Polytechnic State University, San Luis Obispo	University of Alaska Anchorage
California State University, Bakersfield	College of Charleston
California State University, San Bernardino	Oakland University
California State Polytechnic University, Pomona	Towson University
California State University, Chico	Minnesota State University, Mankato
California State University, Dominguez Hills	Southeastern Louisiana University
California State University, Fresno	Ball State University
California State University, Fullerton	Kennesaw State University
California State University, Long Beach	Georgia Southern University
California State University, Los Angeles	Appalachian State University
California State University, Northridge	Western Washington University
California State University, Sacramento	University of West Florida
University of California, Davis	University of California, Berkeley
University of California, Irvine	University of Georgia
University of California, Riverside	University of Louisville
University of California, Santa Barbara	Wayne State University
University of California, Santa Cruz	University of Louisiana at Lafayette
Charles R. Drew University of Medicine and Science	Rosalind Franklin University of Medicine and Science
Humboldt State University	North Carolina Central University
Loma Linda University	University of Tulsa
Mills College	Connecticut College
San Diego State University	Cleveland State University
San Francisco State University	Boise State University
San Jose State University	University of Minnesota, Duluth
University of Central Florida	University of South Carolina, Columbia
Florida Atlantic University	University of North Carolina at Charlotte, The
Florida International University	Auburn University, Auburn
Nova Southeastern University	Fordham University
Georgia State University	University of Delaware
University of Hawaii at Hilo	University of Maryland Eastern Shore
University of Hawaii at Manoa	University of Connecticut

MSI	Non-MSI
University of Illinois at Chicago	Colorado State University, Fort Collins
Rush University	Morehouse School of Medicine
University of Maryland, Baltimore County	University of Southern Mississippi, The
University of Massachusetts Lowell	University of Wyoming
University of Nevada, Las Vegas	University of Oregon
Montclair State University	Central Michigan University
Rutgers, The State University of New Jersey, Newark	Louisiana Tech University
New Mexico Institute of Mining and Technology	Delaware State University
University of New Mexico, The	Virginia Commonwealth University
New Mexico State University	University of North Dakota
City University of New York, The, Baruch College	Central Washington University
City University of New York, The, Brooklyn College	University of Central Oklahoma
City University of New York, The, The City College	University of Toledo, The
City University of New York, The, Graduate Center, The	Kent State University
City University of New York, The, Hunter College	United States Air Force Academy
City University of New York, The, John Jay College Criminal Justice	Youngstown State University
City University of New York, The, Lehman College	St. Cloud State University
City University of New York, The, Queens College	University of Michigan, Dearborn
New York Institute of Technology	Saint Joseph's University
St. John's University, New York	DePaul University
Pacific University	Clark Atlanta University
Texas A&M University-Corpus Christi	University of South Dakota, The
University of Houston-Clear Lake	University of Texas at Tyler, The
University of Houston-Downtown	Eastern Washington University
University of Houston	George Mason University
Texas A&M International University	University of Wisconsin-Stevens Point
University of North Texas, Denton	University of Alabama, The, Tuscaloosa
University of Texas Rio Grande Valley, The	East Carolina University
Sam Houston State University	Western Kentucky University
Texas State University	Portland State University
Sul Ross State University	Central State University
University of Texas Health Science Center at San Antonio, The	University of Nebraska Medical Center
University of Texas Medical Branch, The	University of Arkansas for Medical Sciences
Texas A&M University-Kingsville	University of Massachusetts Dartmouth
Texas A&M University, College Station and Health Science Center	Ohio State University, The

MSI	Non-MSI
University of Texas at Arlington, The	University of Texas at Dallas, The
University of Texas at Austin, The	Rutgers, The State University of New Jersey, New Brunswick
University of Texas at El Paso, The	University of Montana, The, Missoula
University of Texas at San Antonio, The	Old Dominion University
Texas Tech University	West Virginia University
Texas Woman's University	Lamar University
Texas Tech University Health Sciences Center	Louisiana State University, Health Sciences Center, New Orleans
West Texas A&M University	Southern Connecticut State University
University of Guam	United States Military Academy
Ponce Health Sciences University	Meharry Medical College
University of Puerto Rico at Cayey	Christopher Newport University
University of Puerto Rico at Mayaguez	Alabama A&M University
University of Puerto Rico, Medical Sciences Campus	State University of New York, Upstate Medical University
University of Puerto Rico at Rio Piedras	Marshall University
Universidad Central del Caribe	Albany College of Pharmacy and Health Sciences
Universidad del Turabo	Pace University
California State University, San Marcos	Stephen F. Austin State University
University of Washington, Bothell	Norfolk State University
University of Washington, Tacoma	University of Illinois at Springfield
California State University, Monterey Bay	University of Nebraska at Kearney
University of California, Merced	Missouri University of Science and Technology

EPSCoR

EPSCoR	Non-EPSCoR
Alabama A&M University	United States Military Academy
University of Alabama at Birmingham, The	University of Virginia, Charlottesville
Alabama State University	Rutgers, The State University of New Jersey, Camden
University of Alabama, The, Tuscaloosa	University of North Texas, Denton
Auburn University, Auburn	Wayne State University
University of South Alabama	City University of New York, The, The City College
Tuskegee University	Bryn Mawr College
University of Alaska Anchorage	California Polytechnic State University, San Luis Obispo
University of Alaska Fairbanks	San Diego State University
University of Alaska Southeast	Savannah State University
University of Arkansas at Little Rock	Texas Southern University
University of Arkansas for Medical Sciences	University of Texas Medical Branch, The
University of Arkansas, Fayetteville	University of California, Riverside
University of Arkansas Pine Bluff	Virginia State University
Arkansas State University, Jonesboro	West Chester University of Pennsylvania
University of Central Arkansas	University of Texas at Tyler, The
Delaware State University	University of Minnesota, Duluth
University of Delaware	Georgia State University
University of Hawaii at Hilo	University of Maryland Eastern Shore
University of Hawaii at Manoa	University of Connecticut
Boise State University	Portland State University
Idaho State University	East Tennessee State University
University of Idaho	University of Massachusetts Lowell
Grinnell College	Williams College
Iowa State University	University of Illinois at Chicago
University of Iowa	University of Colorado Boulder
University of Northern Iowa	Indiana University-Purdue University, Fort Wayne
Palmer College of Chiropractic, Davenport	Albany College of Pharmacy and Health Sciences
University of Kansas	Washington State University
Kansas State University	Texas Tech University
Pittsburg State University	Albany State University
Wichita State University	Cleveland State University
Eastern Kentucky University	Indiana State University
Kentucky State University	Lincoln University, Jefferson City
University of Kentucky	State University of New York, University at Buffalo
University of Louisville	New Jersey Institute of Technology

EPSCoR	Non-EPSCoR
Morehead State University	University of Wisconsin-La Crosse
Murray State University	University of Wisconsin-Green Bay
Northern Kentucky University	Texas A&M University-Commerce
Western Kentucky University	Sam Houston State University
Dillard University	Pomona College
Louisiana State University, Health Sciences Center, New Orleans	State University of New York, Upstate Medical University
Louisiana Tech University	Rutgers, The State University of New Jersey, Newark
University of New Orleans	Prairie View A&M University
University of Louisiana at Monroe	University of Houston-Clear Lake
Southeastern Louisiana University	University of Houston-Downtown
Southern University and A&M College, Baton Rouge	University of Northern Colorado
University of Louisiana at Lafayette	University of California, Santa Cruz
Tulane University	Rice University
Xavier University of Louisiana	Wesleyan University
Bates College	Hamilton College
Bowdoin College	Occidental College
Colby College	Macalester College
University of Maine	University of Texas at Dallas, The
University of New England	Texas Christian University
Alcorn State University	Montana Tech of University of Montana
Jackson State University	Tennessee State University
University of Mississippi	Montana State University, Bozeman
Mississippi State University	State University of New York, Stony Brook University
University of Southern Mississippi, The	University of Memphis, The
Tougaloo College	Harvey Mudd College
Creighton University	Villanova University
University of Nebraska at Kearney	University of Washington, Tacoma
University of Nebraska at Omaha	University of Missouri, Saint Louis
University of Nebraska Medical Center	University of Texas Health Science Center at San Antonio, The
University of Nebraska-Lincoln	University of Missouri, Columbia
University of Nevada, Las Vegas	University of Texas at El Paso, The
University of Nevada, Reno	State University of New York, University at Albany
Dartmouth College	Carnegie Mellon University
University of New Hampshire	University of Oregon
New Mexico Institute of Mining and Technology	Humboldt State University
University of New Mexico, The	University of California, Santa Barbara

EPSCoR	Non-EPSCoR
New Mexico State University	Michigan Technological University
University of North Dakota	William & Mary
North Dakota State University	George Mason University
University of Central Oklahoma	City University of New York, The, Lehman College
Langston University	Norfolk State University
Oklahoma State University, Center for Health Sciences	State University of New York College of Optometry
Oklahoma State University, Stillwater	University of Houston
University of Tulsa	Loma Linda University
Brown University	Georgetown University
University of Rhode Island	University of Massachusetts Boston
Roger Williams University	Niagara University
College of Charleston	California State University, Bakersfield
Claflin University	Union College, Schenectady
Clemson University	Virginia Commonwealth University
Furman University	Oberlin College
Medical University of South Carolina	University of Massachusetts Medical School
University of South Carolina, Columbia	Florida International University
Coastal Carolina University	State University of New York, College at Brockport, The
South Carolina State University	Fort Valley State University
Black Hills State University	State University of New York College, Geneseo
South Dakota State University	Wright State University
University of South Dakota, The	Texas A&M University-Corpus Christi
Middlebury College	Calvin College
University of Vermont	Indiana University-Purdue University, Indianapolis, IUPUI
Marshall University	University of North Carolina at Wilmington, The
West Virginia State University	University of North Carolina at Asheville, The
West Virginia University	University of Central Florida
University of Wyoming	Northern Arizona University
University of Guam	University of Washington, Bothell
Ponce Health Sciences University	Charles R. Drew University of Medicine and Science
University of Puerto Rico at Cayey	Sul Ross State University
University of Puerto Rico at Mayaguez	University of West Florida
University of Puerto Rico, Medical Sciences Campus	Texas Tech University Health Sciences Center
University of Puerto Rico at Rio Piedras	Northern Illinois University
Universidad Central del Caribe	Western University of Health Sciences
Universidad del Turabo	Pace University

EPSCoR	Non-EPSCoR
University of the Virgin Islands	North Carolina Central University
Louisiana State University, Health Sciences Center, Shreveport	Eastern Virginia Medical School

Abbreviations

AANAPISIs	Asian American and Native American Pacific Islander-Serving Institutions
ANNHs	Alaska Native and Native Hawaiian-serving institutions
DEIA	Diversity, Equity, Inclusion, and Accessibility
EHR	Education and Human Resources
EPSCoR	Established Program to Stimulate Competitive Research
GLMM	generalized linear mixed-effects models
HBCUs	Historically Black Colleges and Universities
HERD	Higher Education Research and Development
HSIs	Hispanic-Serving Institutions
IDA	Institute for Defense Analyses
IHE	Institution of Higher Education
IPEDS	Integrated Postsecondary Education Data System
ISTC	International Science and Technology Cooperation
MSIs	Minority-Serving Institutions
NASNTIs	Native American-Serving Nontribal Institutions
NSF	National Science Foundation
NSTC	National Science and Technology Council
OSTP	Office of Science and Technology Policy
PBIs	Predominantly Black Institutions
R&RA	Research and Related Activities
S&T	science and technology
STEM	science, technology, engineering, and mathematics
STPI	Science and Technology Policy Institute
TCCUs	Tribally Controlled Colleges and Universities
WoS	Web of Science

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