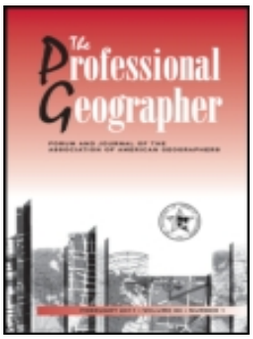

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# Productivity of Doctoral Graduate Placement Among PhD-Granting Geography Programs in the United States: 1960–2010*

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We use a network analysis approach to assess the productivity of research doctoral geography programs in the United States based on data about faculty members who received their PhDs during the period from 1960 to 2010 and held tenured or tenure-track positions in PhD-granting geography programs in the United States during the 2009–2010 academic year. This study reveals the most productive programs that placed the highest number of doctoral graduates in PhD-granting geography programs in the nation. In addition, we discuss the changes of placement productivity of various programs over time and illustrate the centrality of different doctoral programs. Furthermore, results from a correlation analysis suggest that the ranking of research doctoral geography programs based on the placement productivity measures presented in this article resembles the 1995 National Research Council (NRC) ranking of research doctoral geography programs reasonably well and significantly correlates with three major ratings, the S-Rank, the R-Rank, and research, in the 2010 NRC ranking. **Key Words: education, geography, network analysis, PhD exchange network, research doctoral programs.**

我们根据有关在 1960 年到 2010 年间获得博士学位，和在 2009-2010 学年在美国授予地理博士学位的专业科系拥有终身教授职称或终身职位的教师成员的数据，使用网络分析方法来评估美国地理博士专业的研究生产力。这项研究揭示了生产力最高的专业科系，它们在全国的授予博士学位的地理专业科系放置了最多数目的博士毕业生。此外，我们将讨论随着时间的推移，各个专业科系的安置生产力的变化，并说明不同的博士课程的中心地位。此外，相关分析结果表明，本文中基于安置生产力尺度的地理博士专业研究排名，与 1995 年全国研究理事会（NRC）的地理博士专业排名相当类似，并与 2010 年的 NRC 三大评级排名，即 S 等级，R 等级，和研究等，显著相关。**关键词：教育，地理，网络分析，博士交换网，研究性的博士专业。**

Utilizamos un método de análisis de red para evaluar la productividad de los programas de investigación doctoral en geografía en los Estados Unidos, basado en datos sobre profesores que recibieron sus doctorados en el período 1960 a 2010 y ocuparon cargos de profesores permanentes o no permanentes en las concesiones de programas de doctorados en geografía en los Estados Unidos durante el año académico 2009-2010. Este estudio revela los programas más productivos que tuvieron el mayor número de graduados de doctorado en concesiones de programas de doctorados en geografía en la nación. Además, se discuten los cambios de productividad en la colocación de varios programas en el tiempo y se ilustra la importancia de diferentes

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programas de doctorado. Además, los resultados de un análisis de correlación sugieren que el ranking de programas de investigación doctoral en geografía basadas en las medidas de productividad en la colocación presentadas en este artículo se asemejan razonablemente bien al ranking de programas de investigación doctoral en geografía de 1995 del Consejo Nacional de Investigación (NRC) y se correlacionan significativamente con tres principales clasificaciones, el S-Rank, el R-Rank, y la investigación, en el ranking 2010 del NRC. **Palabras claves: educación, geografía, análisis de redes, red de intercambio de PhD, programas de investigación doctoral.**

In addition to other productivity measures such as scholarly publications, teaching outcomes, citations of scholarly work, and reputational ratings from peers (Goldberger, Maher, and Flattau 1995; Groop and Schaetzl 1997), information about placement of doctoral graduates into faculty positions provides insights about the quality of research doctoral programs in a given discipline (Schmidt and Chingos 2007; Barnett et al. 2010). The placement of doctoral graduates from one program to another can be represented by a network consisting of nodes representing academic programs and links connecting the placing and receiving programs. This network is called a *PhD exchange network*.

Information about the placement of doctoral graduates of different programs is useful to prospective students in their planning of doctoral studies and subsequent career paths. Past research has demonstrated that the prestige of programs exerts a significant impact on academic job placement of the alumni of a program, especially for their first jobs (Baldi 1994). In addition, previous studies suggested that the PhD exchange network is one of the most important networks among academic programs, and connections of different programs represented by the network influence the reputation of a program (Burris 2004). The placement of past doctoral graduates of a program influences the prestige of the program, which, in turn, affects the placement of future doctoral graduates of that program. For example, established researchers graduated from a given program could help create a better image for their alma mater, and this improved image and enhanced reputation, through a cumulative process over time, would help increase the chances for doctoral graduates of that program to secure faculty positions (Burris 2004; Stephen 2008).

An analysis of a PhD exchange network in a given discipline provides one objective way to assess the productivity of doctoral programs in that discipline. This objective evaluation serves as a complement to conventional assessment methods based on other productivity measures. In addition, it overcomes the subjective nature of program evaluation based on reputational data (Neuendorf et al. 2007) and thus minimizes the impacts of halo effects on the outcome of an evaluation. The halo effects suggest that university fame significantly influences the reputation of a program in a particular discipline when subjective opinions are used in the evaluation of a program (Feeley 2002; Burris 2004; Schmidt and Chingos 2007).

For geography programs in the United States, some experienced substantial growth in recent decades, and some universities established doctoral programs in geography over these decades. For example, only thirty-six geography programs were included in the 1995 National Research Council (NRC) ranking of research doctoral geography programs (Goldberger, Maher, and Flattau 1995), but the number of PhD-granting geography programs was almost doubled by 2010, with seventy-two universities offering a PhD program in geography or closely related disciplines. Although the NRC provided rankings of research doctoral geography programs in 1995 and more recently in 2010, neither of these two rankings contained detailed information about the productivity of doctoral graduate placement of various programs. The study reported in this article attempts to fill this void.

The productivity of geography programs in the United States has been studied from various perspectives. Some studies focused on teaching quality using subjective and reputational data (Solem, Cheung, and Schlemper 2008; Solem and Foote 2009; Solem, Lee, and Schlemper 2009). Other studies analyzed productivity profiles of different programs based on objective measures such as publications, author citations, external funding, and teaching outcomes (Morrill 1980; Turner and Meyer 1985; Trimble 1987; Groop and Schaetzl 1997). Among these assessments, Turner and Meyer (1985) applied a bibliometric approach to evaluate the scholarly productivity of doctoral

geography programs, Wheeler (1990) analyzed publications from selected geography programs in the United States, and Groop and Schaetzl (1997) provided a variety of measures to assess program productivity, including placement of doctoral graduates at PhD- and master's-granting geography programs in North America.

These studies, however, did not employ a network perspective when assessing placement productivity, failing to take advantage of the objective information represented in the PhD exchange network that can be collected relatively easily. In contrast, researchers in other disciplines used PhD exchange networks to assess productivity of different programs. For example, Hanneman (2001) quantitatively investigated the relationships between interdepartmental job exchanges and departmental prestige in sociology. Burris (2004) used a PhD exchange network to assess program prestige in political science, sociology, and history. In another study, Barnett and colleagues (2010) analyzed faculty hiring data to measure the quality of PhD programs in communication.

In this study, we evaluate the productivity of research doctoral geography programs in the United States through an examination of the characteristics of a PhD exchange network. Specifically, this study aims to (1) assess the productivity of a doctoral geography program based on the placement of doctoral graduates in research doctoral geography programs; (2) examine the changes of the productivity of doctoral graduate placement of various programs over time; (3) evaluate the connectedness and centrality of a program based on the exchange of doctoral graduates among different programs; and (4) analyze the correlation between the rating of program productivity as measured by placement of doctoral graduates and the 1995 and 2010 NRC rankings.

## Data and Methods

### *Data Collection*

We collected data about 1,133 faculty members who had a PhD in hand and held tenured or tenure-track positions in the 2009–2010 academic year at seventy-two PhD-granting programs in the United States. Faculty who either retired by the spring of 2010 or held other positions (e.g., research and adjunct faculty members) were not included in the analysis. For each faculty member, we retrieved the following information: name, affiliation as of the spring of 2010, program where a person received his or her PhD, year of degree, and whether the degree was from a geography program. When collecting the data, we constructed the initial database based on materials documented in the 2009–2010 edition of the *Guide to Geography Programs in the Americas* prepared and distributed by the Association of American Geographers (AAG 2010). The guide contained information about sixty-nine PhD-granting geography programs. In addition to the sixty-nine programs, we managed to find information about three more programs (University of Florida, the University of Maryland–Baltimore County, and the University of North Carolina at Greensboro) that offered PhD programs in the 2009–2010 academic year from online sources (Geography departments in North America 2008), giving a total of seventy-two programs in the database.

After an initial screening of the seventy-two programs, we identified the program at Johns Hopkins University as a special case. Because this program has an emphasis on engineering, we decided not to include this program in the ranking that is discussed in later sections of this article, but we included the program in the analysis because this program placed doctoral graduates in other doctoral geography programs. For departments with joint programs between geography and other disciplines, we only included data about faculty members in the respective geography programs in the analyses.

There are some special cases among the seventy-two programs. The geography program at Louisiana State University (Louisiana State) underwent some restructuring around 2008, and we only included those Louisiana State geography faculty members who are currently affiliated with the geography program. Faculty members who received their degree from the joint PhD program between San Diego State University (San Diego State) and the University of California at Santa Barbara (UC Santa Barbara) were classified as doctoral graduates from San Diego State. We also included geography programs that participate in interdisciplinary doctoral research programs in the analysis. These interdisciplinary programs include the programs at the Graduate Center at the City University of

New York (CUNY), Portland State University, University of California at Davis, University of Maryland–Baltimore County, University of Missouri–Kansas City, University of Southern Florida, and Virginia Tech.

To find out if a geography faculty member received his or her PhD from a geography program, we first sent e-mails to individual department chairs requesting the information and then browsed Web sites of different programs to complete the search based on online materials that were available to the general public as of the spring of 2010. We received responses from thirty-five department chairs (a 48 percent response rate). For faculty members in the other thirty-seven programs, we extracted degree information from their curriculum vitae, departmental alumni lists, or other publicly available materials at the respective departmental Web sites. We excluded five faculty members from the initial database because we could not confirm either their graduation year or the institutions where they received their PhDs, giving a total of 1,133 faculty members whose information was used in the analysis.

The data just described allowed us to construct a 72-by-72 matrix representing the PhD exchange network among the seventy-two programs where the 1,133 faculty members held tenured or tenure-track positions in the 2009–2010 academic year. These 1,133 faculty members graduated from 157 universities. A total of 834 (74 percent) of the 1,133 faculty members received their PhDs in geography, and the other 299 (26 percent) obtained their PhDs in other disciplines. A total of 710 (63 percent) of these 1,133 people received their PhDs from the seventy-two programs, and the remaining 423 (37 percent) graduated from other programs.

The diverse disciplinary backgrounds of the faculty in the seventy-two programs reflected the interdisciplinary nature of the discipline. Geography programs attracted scholars from various disciplines, including sociology, environmental sciences, atmospheric and planetary sciences, urban planning, and geosciences. For example, among the 1,133 people, seventeen received their PhDs from Cornell University, twelve from Columbia University, and seven from Harvard University, although none of these three Ivy League universities offered a doctoral program in geography. The seventy-two geography programs also employed people with a PhD from universities in other countries. Among these people, five earned their doctorates from Oxford University in the United Kingdom, two from Peking University in China, fifteen from the University of Toronto in Canada, and ten from the McMaster University in Canada.

## Data Analysis

### *Absolute and Relative Placement Productivity*

Absolute placement productivity of a program refers to the number of doctoral graduates in that program who held tenure-track or tenured faculty positions in any of the seventy-two programs during the 2009–2010 academic year. As already stated, this productivity measure reveals a program's overall strength in terms of placing doctoral graduates into faculty positions in research doctoral geography programs. One might argue that absolute placement productivity is significantly correlated with the size of a program because larger programs with more faculty members have the capacity to produce more graduates (Burris 2004; Barnett et al. 2010). Therefore, relative placement productivity determined by the number of placement per faculty member can be used as a complementary indicator to measure placement productivity (Groop and Schaetzl 1997). This relative productivity measure allows us to compare the placement productivity of geography programs that are significantly different in size. We therefore use both absolute and relative productivity measures in this study.

### *Rank Clock and Program Dynamics*

We employed rank clock (Batty 2006; Collins et al. 2008) to examine the change of placement productivity of the programs over time. To achieve this goal, we first divided the fifty-one-year study period into four time intervals: 1960 to 1980, 1981 to 1990, 1991 to 2000, and 2001 to 2010. We then aggregated the number of doctoral graduates that each geography program had placed in any of the seventy-two programs during each of the four time intervals and generated the rank clock of each program.

The rank-ordered productivity of each program was plotted starting with a vertical axis at twelve o'clock. The most productive

program (ranked number one) for the period from 1960 to 1980 was plotted at the bottom of this first vertical axis, with decreasing ranks at progressively higher positions along the same axis. For the other three time intervals, the ranks for 1981 to 1990 were then plotted in the same order along a second axis at four o'clock, the ranks for 1991 to 2000 at eight o'clock, and the ranks for 2001 to 2010 at twelve o'clock again.

The changes of a program's rank in productivity over time can be illustrated by linking the rank of the respective program on each axis from one time interval to the next in a clockwise direction. A centripetal trajectory of the linked ranks of a program indicates the productivity of that program is growing. If the productivity of a program is stable, then the trajectories of the linked ranks of that program would form a clock composed of concentric and nonoverlapping circles. If the trajectories of a program contain intersecting line segments, then the productivity of that program over time is fluctuating. A centrifugal trajectory of a program's linked ranks means the productivity of that program is declining.

### *Centrality and Connectedness of a Program on the PhD Exchange Network*

We employed a number of network centrality indicators to measure the relative importance of a program on the PhD exchange network. These centrality indicators include eigenvector, out-degree, and in-degree centrality. Eigenvector centrality assigns numeric scores to all nodes and the scores reflect the relative importance of these nodes (Ahuja, Magnanti, and Orlin 1993; Borgatti, Everett, and Freeman 2002). The scores are assigned based on the principle that connections from one node to other nodes with higher scores contribute more to the score of that node and vice versa. The out-degree centrality is the same as the absolute placement productivity, and it is the number of links emanating from a node. The in-degree centrality measures the number of graduates that a program has hired from other programs. We used the UCINET network analytical software to compute the values of centrality indicators (Borgatti, Everett, and Freeman 2002). In addition, the UCINET procedures can be used to detect subgroups on a network based on connectivity among nodes. These subgroups help reveal subclusters among the seventy-two geography programs.

## Results

### *Placement Productivity of Geography Programs*

The thirty most productive research doctoral geography programs over the period from 1960 to 2010, as measured by the number of doctoral graduates placed into faculty positions at PhD-granting geography programs, are presented in Table 1. Information about the number of geography faculty members who held faculty positions in PhD-granting geography programs but received their PhDs from other disciplines in each institution is also provided in Table 1.

***Table 1*** *Top thirty most productive programs ranked by the number of doctoral graduates placed in PhD-granting programs, 1960–2010*

| Institution | Number of doctoral graduates from geography program (rank) | Number of doctoral graduates from other programs in the same institution |
|---|---|---|
| UC–Berkeley | 42 (1) | 35 |
| Ohio State | 41 (2) | 4 |
| Colorado | 41 (2) | 5 |
| Wisconsin–Madison | 39 (4) | 5 |
| UC–Santa Barbara | 32 (5) | 1 |
| Minnesota | 28 (6) | 5 |
| UC–Los Angeles | 27 (7) | 3 |
| Penn State | 27 (7) | 1 |
| Clark | 22 (9) | 1 |
| Kansas | 22 (9) | 0 |
| Washington | 21 (11) | 8 |
| Rutgers | 20 (12) | 2 |
| Iowa | 19 (13) | 0 |
| SUNY Buffalo | 18 (14) | 2 |
| Syracuse | 18 (14) | 1 |
| Georgia | 18 (14) | 3 |
| Arizona | 17 (17) | 11 |
| Illinois–UC | 17 (17) | 3 |
| Michigan State | 17 (17) | 1 |
| Arizona State | 15 (20) | 2 |
| South Carolina | 14 (21) | 1 |
| Louisiana State | 13 (21) | 1 |
| UNC–Chapel Hill | 13 (23) | 2 |
| Texas | 12 (24) | 0 |
| Nebraska | 11 (25) | 1 |
| Tennessee | 11 (26) | 0 |
| Kentucky | 10 (27) | 0 |
| Indiana | 10 (27) | 3 |
| Wisconsin–Milwaukee | 9 (29) | 1 |
| Oklahoma | 9 (29) | 1 |

The geography programs that had placed the highest number of doctoral graduates in PhD-granting geography programs are the University of California at Berkeley (UC–Berkeley), the Ohio State University (Ohio State), and the University of Colorado at Boulder (Colorado). Each of these three programs had more than forty doctoral graduates who held faculty positions in various PhD-granting geography programs in the spring of 2010.

As stated earlier, 710 of the 1,133 faculty members were graduates from the seventy-two programs and 423 (37 percent) received their PhDs from other programs. Among the 710 people, 613 were from the top thirty programs (Table 1) and 97 graduated from the other forty-two of the seventy-two programs. This demographic composition suggests that the hiring pattern in research doctoral geography programs from 1960 to 2010 was rather concentrated, with more than half of the positions held by graduates from the top thirty most productive programs. This pattern is similar to those identified in other disciplines (Burris 2004; Barnett et al. 2010).

In addition to the two Canadian geography programs at the University of Toronto and McMaster University, two other programs in North America each placed ten or more doctoral graduates in the seventy-two programs: the University of Michigan and the University of Chicago. Another observation is that thirty-five doctoral graduates in other disciplines from UC–Berkeley held faculty positions in geography programs. This situation could be attributed to the fact that UC–Berkeley has a strong environmental science program that emphasizes spatial thinking and analysis.

The top thirty geography programs with the highest relative productivity scores are shown in Table 2. UC–Berkeley, the University of Wisconsin–Madison (Wisconsin–Madison), and the University of Iowa (Iowa) performed exceptionally well based on this measure. For example, the geography program at the University of Iowa had only ten tenured or tenure-track faculty members in the spring of 2010, but nineteen Iowa geography doctoral graduates held faculty positions in the seventy-two programs as of the spring of 2010. One might recall that the total number of doctoral graduates that one geography program had placed is the cumulative sum over the fifty-one-year period, but the size of a program was the number of faculty members on record as of the spring of 2010. A more robust measurement of relative productivity would require information about the average program size over the fifty-one-year period as determined by the average number of full-time teaching equivalent (FTE) faculty over the study period (Groop and Schaetzl 1997), but we did not attempt to obtain information about the average FTEs over fifty-one years in each of the programs because the data were not available for all programs in each of the fifty-one years.

***Table 2*** *Thirty most productive programs ranked by the number of doctoral graduates placed in PhD-granting programs per faculty member, 1960–2010*

| Geography program | Relative productivity (rank) |
|---|---|
| UC–Berkeley | 3.23 (1) |
| Wisconsin–Madison | 2.05 (2) |
| Iowa | 1.90 (3) |
| Colorado | 1.71 (4) |
| Ohio State | 1.41 (5) |
| Washington | 1.31 (6) |
| UC–Santa Barbara | 1.28 (7) |
| Clark | 1.22 (8) |
| Minnesota | 1.22 (8) |
| SUNY Buffalo | 1.20 (10) |
| UC–Los Angeles | 1.17 (11) |
| Oregon State | 1.17 (12) |
| Illinois–UC | 1.13 (13) |
| Syracuse | 1.13 (13) |
| Penn State | 1.04 (15) |
| Kansas | 1.00 (16) |
| Tennessee | 0.92 (17) |
| Indiana | 0.91 (18) |
| Arizona | 0.85 (19) |
| South Carolina | 0.82 (20) |
| Georgia | 0.82 (20) |
| Nebraska | 0.79 (22) |
| Louisiana State | 0.76 (23) |
| Oklahoma | 0.75 (24) |
| USC | 0.75 (24) |
| Texas | 0.71 (26) |
| Wisconsin–Milwaukee | 0.69 (27) |
| UNC–Chapel Hill | 0.65 (28) |
| Rutgers | 0.65 (28) |
| Oregon | 0.58 (30) |

To better reflect productivity of doctoral graduate placement of various programs in the most recent two decades, we calculated the absolute and relative placement productivity of all seventy-two programs over the period from 1991 to 2010, inclusive. The thirty most productive programs over this twenty-year period are listed in Table 3. When rated based on absolute placement productivity over

***Table 3*** *Top thirty most productive programs ranked by the number of doctoral graduates placed in PhD-granting programs, 1991–2010*

| Institution | Absolute productivity (rank) | Relative productivity (rank) |
|---|---|---|
| **UC–Santa Barbara** | 26 (1) | 1.00 (3) |
| **UC–Berkeley** | 21 (2) | 1.62 (1) |
| **Colorado** | 21 (2) | 0.88 (6) |
| **Penn State** | 19 (4) | 0.73 (10) |
| **Wisconsin–Madison** | 18 (5) | 0.95 (4) |
| Ohio State | 18 (5) | 0.62 (13) |
| **Clark** | 16 (7) | 0.89 (5) |
| Minnesota | 14 (8) | 0.61 (14) |
| **SUNY Buffalo** | 13 (9) | 0.87 (7) |
| **South Carolina** | 13 (9) | 0.76 (8) |
| Arizona | 13 (9) | 0.65 (12) |
| UC–Los Angeles | 13 (9) | 0.57 (17) |
| **Iowa** | 12 (13) | 1.20 (2) |
| Georgia | 12 (13) | 0.55 (20) |
| Arizona State | 12 (13) | 0.33 (30) |
| Texas | 10 (16) | 0.59 (15) |
| Rutgers | 10 (16) | 0.32 (33) |
| Washington | 9 (18) | 0.56 (18) |
| Syracuse | 9 (18) | 0.56 (18) |
| UNC–Chapel Hill | 9 (18) | 0.45 (24) |
| Michigan State | 9 (18) | 0.28 (37) |
| Tennessee | 8 (22) | 0.67 (11) |
| Louisiana State | 8 (22) | 0.47 (21) |
| Kentucky | 8 (22) | 0.44 (25) |
| Oregon | 7 (25) | 0.58 (16) |
| Illinois–UC | 7 (25) | 0.47 (22) |
| Kansas | 7 (25) | 0.32 (35) |
| Nebraska | 6 (28) | 0.43 (26) |
| San Diego State | 6 (28) | 0.38 (28) |
| Texas State | 6 (28) | 0.22 (38) |

*Note:* Programs highlighted in bold are among the top ten programs in relative placement productivity.

this twenty-year period, the most productive programs are, in rank order, UC–Santa Barbara, UC–Berkeley, Colorado, Penn State, Wisconsin–Madison, Ohio State, Clark, Minnesota, SUNY Buffalo, UC–Los Angeles, Arizona, and South Carolina (Table 3). The top programs in relative placement productivity are, in rank order, UC–Berkeley, Iowa, UC–Santa Barbara, Wisconsin–Madison, Clark, Colorado, SUNY Buffalo, South Carolina, USC, and Penn State (Table 3).

### *Temporal Changes of Placement Productivity*

Results about the changes of placement productivity of different programs over the four time intervals are shown in Figure 1. Example programs that experienced growth in placement productivity in the fifty-one-year period included UC–Santa Barbara, Arizona State University (Arizona State), and Clark University (Clark; Figure 1A). For example, there were only six geography doctoral graduates from UC–Santa Barbara who received their PhDs before 1991 and still held faculty positions in the seventy-two programs in the spring of 2010, but there were twenty-six graduates who obtained their PhDs in geography from UC–Santa Barbara over the period from 1991 to 2010 and were on the faculty of different doctoral geography programs in the 2009–2010 academic year. Similarly, the geography program at Arizona State placed twelve graduates in doctoral geography programs from 1991 to 2010, but only five faculty members in these seventy-two programs in the spring of 2010 received their PhDs in geography at Arizona State between 1960 and 1990.

Placement productivity in most well-established programs remained stable over the study period (Figure 1B). Examples of these programs include UW–Madison, UC–Berkeley, Washington, Ohio State, Penn State, UC–Los Angeles, and Colorado. Most of these programs are also among the most productive programs evaluated in other studies (Groop and Schaetzl 1997).

Placement productivity in some programs exhibited certain level of fluctuation during different time intervals (Figure 1C). For example, from 1991 to 2000, eight doctoral graduates from Iowa secured faculty positions in the seventy-two geography programs, whereas only four obtained such positions over the period from 2001 to 2010. We acknowledge, though, that these fluctuations of individual programs' ranks could well be caused by various factors such as job relocation and retirements of faculty members.

As expected, some programs experienced declines in placement productivity, including Michigan, Chicago, and Johns Hopkins. As is well known within the discipline, geography programs at Michigan and Chicago have maintained limited operations in recent decades, and the focus of the Department of Geography and Environmental Engineering at Johns Hopkins has been shifted to engineering in recent decades.

### *Program Connectedness and Centrality*

The PhD exchange network consists of 710 links. Among these links, 252 (35.4 percent) are bidirectional, 413 (58.2 percent) are one way,

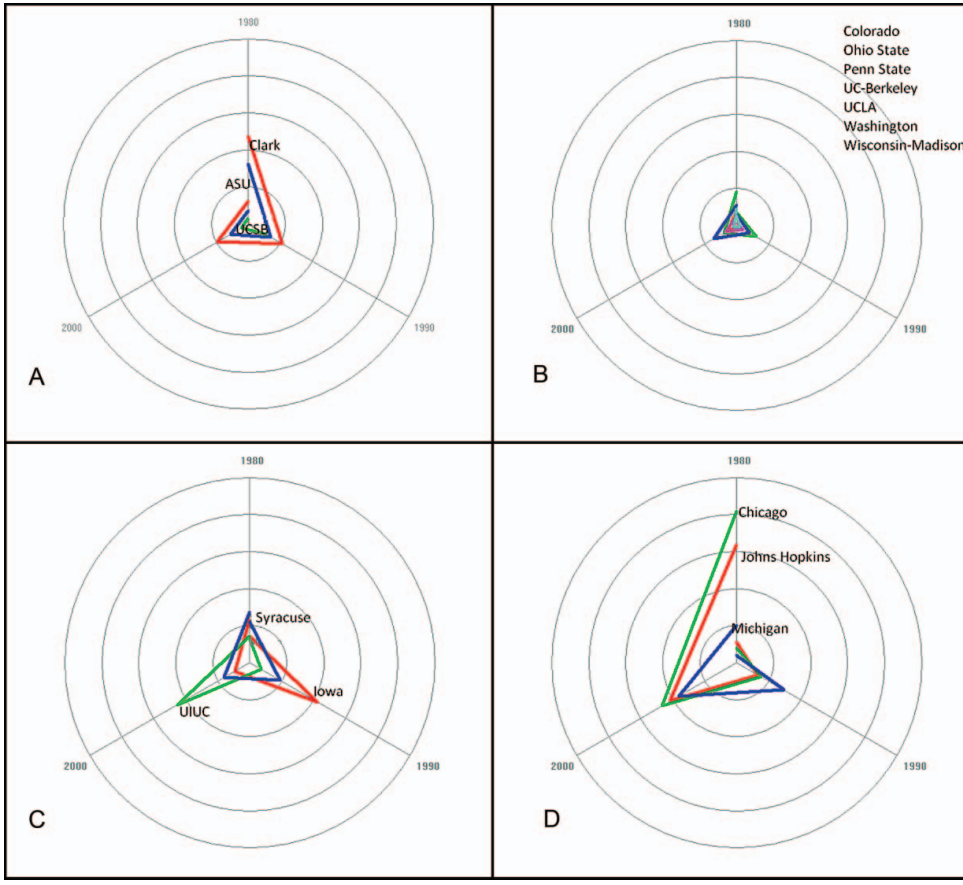


**Figure 1** *Rank clocks of temporal dynamics of program productivity (in clockwise order): (A) examples of growing programs, (B) examples of stable programs, (C) examples of fluctuating programs, and (D) examples of declining programs. (Color figure available online.)*

and 45 (6.3 percent) form loops. A bidirectional link indicates that the two programs at the two ends of the link exchanged doctoral graduates with each other, and a looped link means that a program hired its own graduates. The overall density of the network, as measured by the ratio between the total number of existing links and the total number of possible links in the network, is rather sparse at 0.13. In other words, only 13 percent of the possible exchange of PhD graduates existed. No department placed its graduates in all seventy-one other departments, and no department hired PhD graduates from all seventy-one other departments. This network sparseness implied that there was no thorough blending among departments, and doctoral geography programs possibly tend to hire graduates from certain programs. Again, this concentrated hiring pattern coincides with those identified in other disciplines (Hanneman 2001; Burris 2004; Barnett et al. 2010).

The thirty programs with the highest scores in eigenvalue centrality based on data over the period from 1960 to 2010 are listed in Table 4, and the top thirty programs based on data from 1991 to 2010 are listed in Table 5. Eigenvalue centrality measures the relative importance and connectedness of a program within the network, taking into account both placement and hiring of doctoral graduates. A larger eigenvalue of a program represents

***Table 4*** *Top thirty programs with the highest scores of centrality on the PhD exchange network, 1960–2010*

| Geography program | Eigenvalue (rank) | Out-degree (rank) | In-degree (rank) |
|---|---|---|---|
| Ohio State | 41.08 (1) | 41 (2) | 20 (4) |
| Colorado | 37.41 (2) | 41 (2) | 11 (25) |
| Wisconsin–Madison | 34.32 (3) | 39 (4) | 9 (38) |
| UC–Berkeley | 32.79 (4) | 42 (1) | 5 (59) |
| UC–Los Angeles | 30.48 (5) | 27 (7) | 11 (25) |
| Penn State | 29.98 (6) | 27 (7) | 17 (5) |
| Washington | 27.44 (7) | 21 (11) | 12 (19) |
| Minnesota | 27.08 (8) | 28 (6) | 12 (19) |
| Kansas | 24.92 (9) | 22 (9) | 16 (7) |
| Arizona State | 24.04 (10) | 15 (20) | 21 (2) |
| UC–Santa Barbara | 23.02 (11) | 32 (5) | 4 (67) |
| Georgia | 22.62 (12) | 18 (14) | 15 (9) |
| Michigan State | 21.93 (13) | 17 (17) | 21 (2) |
| South Carolina | 21.78 (14) | 14 (21) | 16 (7) |
| Rutgers | 21.35 (15) | 20 (12) | 11 (25) |
| Texas State | 21.14 (16) | 6 (34) | 23 (1) |
| Arizona | 20.92 (17) | 17 (17) | 13 (13) |
| Illinois–UC | 20.42 (18) | 17 (17) | 9 (38) |
| UNC–Chapel Hill | 20.23 (19) | 13 (22) | 17 (5) |
| Syracuse | 19.80 (20) | 18 (14) | 12 (19) |
| Clark | 19.02 (21) | 22 (9) | 10 (28) |
| Kentucky | 17.21 (22) | 10 (27) | 13 (13) |
| Texas | 16.74 (23) | 12 (24) | 12 (19) |
| Iowa | 15.61 (24) | 19 (13) | 7 (52) |
| SUNY Buffalo | 15.33 (25) | 18 (14) | 8 (46) |
| San Diego State | 15.26 (26) | 6 (34) | 10 (28) |
| Tennessee | 14.94 (27) | 11 (25) | 10 (28) |
| Oregon | 13.88 (28) | 7 (32) | 8 (46) |
| Delaware | 13.40 (29) | 6 (34) | 10 (28) |
| Louisiana State | 13.34 (30) | 13 (22) | 13 (13) |

*Note:* The program at Johns Hopkins University was used in the analyses, but it is not listed in this table due to the fact that it is more appropriate to classify the program as an engineering program.

***Table 5*** *Top thirty programs with the highest scores of centrality on the PhD exchange network, 1991–2010*

| Geography program | Eigenvalue (rank) | Out-degree (rank) | In-degree (rank) |
|---|---|---|---|
| Ohio State | 34.90 (1) | 18 (5) | 11 (4) |
| Colorado | 32.10 (2) | 21 (2) | 5 (36) |
| UC–Santa Barbara | 30.66 (3) | 26 (1) | 1 (65) |
| Minnesota | 29.62 (4) | 14 (8) | 9 (11) |
| Georgia | 29.21 (5) | 12 (13) | 12 (2) |
| Penn State | 29.02 (6) | 19 (4) | 6 (27) |
| Arizona State | 28.27 (7) | 12 (13) | 11 (4) |
| Texas State | 27.04 (8) | 6 (28) | 15 (1) |
| Wisconsin–Madison | 26.63 (9) | 18 (5) | 4 (46) |
| UC–Berkeley | 26.43 (10) | 21 (2) | 1 (65) |
| South Carolina | 26.41 (11) | 13 (9) | 10 (8) |
| Arizona | 25.05 (12) | 13 (9) | 8 (15) |
| Clark | 24.98 (13) | 16 (7) | 6 (27) |
| SUNY Buffalo | 24.38 (14) | 13 (9) | 6 (27) |
| Syracuse | 24.28 (15) | 9 (18) | 9 (11) |
| UNC–Chapel Hill | 23.34 (16) | 9 (18) | 11 (4) |
| Rutgers | 22.66 (17) | 10 (16) | 6 (27) |
| Michigan State | 21.44 (18) | 9 (18) | 12 (2) |
| Texas | 18.88 (19) | 10 (16) | 7 (20) |
| San Diego State | 18.73 (20) | 6 (28) | 5 (36) |
| Kentucky | 18.07 (21) | 8 (22) | 7 (20) |
| UC–Los Angeles | 18.00 (22) | 13 (9) | 3 (55) |
| Louisiana State | 17.81 (23) | 8 (22) | 10 (8) |
| Utah | 16.27 (24) | 2 (39) | 9 (11) |
| Iowa | 15.96 (25) | 12 (13) | 3 (55) |
| Texas A&M | 15.67 (26) | 4 (33) | 10 (8) |
| Wisconsin–Milwaukee | 15.11 (27) | 5 (31) | 8 (15) |
| Tennessee | 14.85 (28) | 8 (22) | 5 (36) |
| Denver | 14.83 (29) | 0 (53) | 8 (15) |
| Oregon | 14.44 (30) | 7 (25) | 5 (36) |

a more central role and a higher level of connectedness to the most productive programs in the network, suggesting that the program has placed more doctoral graduates into more PhD-granting programs, hired more graduates from other programs, or both.

An analysis of placement outcomes from the most central geography programs confirms an observation that hires at doctoral geography programs were concentrated around graduates from top-ranked programs. When the centrality of the seventy-two programs is assessed based on data from 1960 to 2010, the top ten programs are Ohio State, Colorado, Wisconsin–Madison, UC–Berkeley, UC–Los Angeles, Penn State, Washington, Minnesota, Kansas, and Arizona State. When the programs are assessed based on data from 1991 to 2010, these top ten programs are Ohio State, Colorado, UC–Santa Barbara, Minnesota, Georgia, Penn State, Arizona State, Texas State University–San Marcos (Texas State), Wisconsin–Madison, and UC–Berkeley.

It was expected that programs with a higher degree of out-degree centrality (i.e., higher absolute placement productivity) would result in a larger eigenvalue. We also noted that programs that have employed more faculty members from central programs would receive a relatively larger eigenvalue. Examples of these programs include geography programs at Texas State and the University of North Carolina–Greensboro (UNC–Greensboro). The scores of eigenvalue centrality for these two programs are considerably higher than their respective ranks in absolute productivity. These two programs experienced significant growth in recent decades and employed

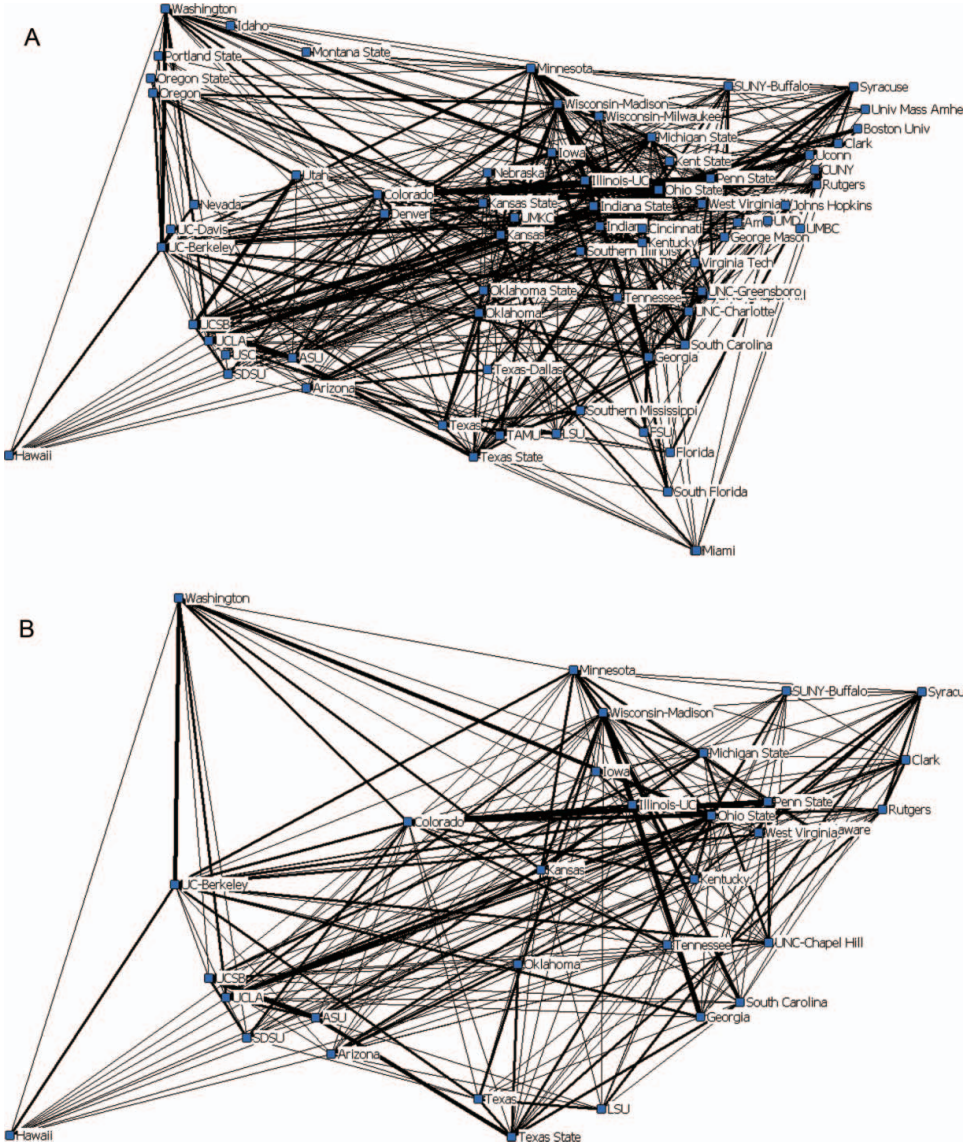


**Figure 2** *The PhD exchange network among PhD-granting geography programs: (A) a network of all seventy-two programs; (B) a network of the thirty-one most central programs in terms of eigenvalue centrality. (Note: The location of a node is represented by the latitude and longitude of the geography department in question, but the locations of some programs were slightly adjusted for clarity of display. The thickness of a line represents the level of exchange between two respective programs.) (Color figure available online.)*

graduates from programs with a higher score of centrality.

We also investigated the connectedness among the seventy-two programs based on a cluster analysis of nodes on the PhD exchange network. This analysis reveals that the seventy-two programs collectively form an integral cluster (Figure 2), meaning that these

programs constitute a single integral entity and there exist no subgroups among the programs.

Two programs are considered to be pairwise well connected if they exchanged more than three doctoral graduates over the study period. The analysis results suggest that several programs were more closely related to each other. Highly ranked programs tend to exchange more graduates among themselves. For example, Ohio State and UC–Los Angeles exchanged five doctoral graduates, as suggested by the thicker link between nodes representing the two programs (Figure 2). In addition, programs can also be linked due to job relocation of faculty members. For example, Arizona State hired four people who received their PhDs at UC–Santa Barbara in recent years, and these hires alone made the Arizona State and UC–Santa Barbara geography programs well connected.

We analyzed geographic patterns in the network by plotting out the PhD exchange network using the geographic coordinates of the locations of these programs (Figure 2). For example, several programs appeared to have tighter links with programs that are geographically close. Examples of these closer ties include Wisconsin–Madison and Minnesota, as well as Iowa and Nebraska. In other cases, several programs tend to link with peers that are geographically distant. Examples of these programs include Clark and Florida, Ohio State and UC–Los Angeles, and Wisconsin–Madison and Georgia.

### *Correlation with the 1995 and 2010 NRC Rankings*

Because the placement data cover a fifty-one-year period from 1960 to 2010, we decided to compare the ranking of program productivity and network centrality from this study with those of the 1995 and 2010 NRC rankings of research doctoral geography programs. The 1995 NRC ranking was essentially based on reputational data (Goldberger, Maher, and Flattau 1995) and the 2010 NRC ranking was more data driven, using data associated with twenty variables that were collected during 2005 and 2006 (Ostriker, Charlotte, and Voytuk 2010). In the 2010 ranking, programs in a discipline can be ranked using five major ratings derived from some combinations of the twenty variables. These five ratings are the S-Rank, research, students, diversity, and R-Rank (Chronicle of Higher Education 2010). The S-Rank is used to assess characteristics of a program that scholars consider most important. The research rating measures faculty scholarly productivity, citation rates of faculty publications, awards, and grants. In the students category, rating is derived from data such as time needed to complete a doctoral degree, completion rate, and proportion of students with financial support, among other criteria. Diversity is measured by ethnic diversity, gender balance, and percentage of foreign students in a program. The R-Rank uses similar features in top-notch programs to rate programs and it ranks a program high if the program has features similar to other programs that are recognized by peers as top-rated programs. The 2010 NRC ranking included forty-nine programs in geography.

The rating from this study resembles the 1995 NRC ranking reasonably well. To make the comparison, we obtained productivity and network centrality measures for the thirty-six programs listed in the 1995 NRC ranking. Eight of the ten most productive programs in placing doctoral graduates in PhD-granting programs in the period from 1961 to 2010 are among the top ten programs in the 1995 NRC ranking. These eight programs are UC–Berkeley, Ohio State, Wisconsin–Madison, UC–Santa Barbara, Minnesota, UC–Los Angeles, Penn State, and Clark (Table 6). Seven of the top ten programs with the highest eigenvalues are also among the top ten programs in the 1995 NRC ranking: Ohio State, Wisconsin–Madison, UC–Berkeley, UC–Los Angeles, Penn State, Washington, and Minnesota (Table 6).

The ranking from this study is also in line with the 2010 NRC ranking. To make the comparison, we introduced a composite score—the overall score—to the 2010 NRC ranking. This overall score is a simple average of the scores of the five ratings previously described. The top ten programs from the 2010 NRC ranking based on the overall score and the top ten programs from this study are listed in Table 7. Because the R-Rank is essentially based on peer views about similar characteristics of top-notch programs and a ranking based on the R-Rank is more closely related to the 1995 ranking, we

***Table 6*** *Top ten programs from the 1995 National Research Council (NRC) ranking and top ten programs based on absolute placement productivity and scores of eigenvalue centrality*

| 1995 NRC ranking (rank) | Absolute productivity (rank) | Eigenvalue centrality (rank) |
|---|---|---|
| Penn State (1) | **UC–Berkeley (1)** | **Ohio State (1)** |
| Wisconsin–Madison (2) | **Ohio State (tie for 2)** | Colorado (2) |
| Minnesota (3) | Colorado (tie for 2) | **Wisconsin–Madison (3)** |
| UC–Santa Barbara (4) | **Wisconsin–Madison (4)** | **UC–Berkeley (4)** |
| Ohio State (5) | **UC–Santa Barbara (5)** | **UC–Los Angeles (5)** |
| UC–Berkeley (tie for 6) | **Minnesota (6)** | **Penn State (6)** |
| Syracuse (tie for 6) | **Penn State (tie for 7)** | **Washington (7)** |
| UC–Los Angeles (8) | **UC–Los Angeles (tie for 7)** | **Minnesota (8)** |
| Clark (9) | **Clark (tie for 9)** | Kansas (9) |
| Washington (10) | Kansas (tie for 9) | Arizona State (10) |

*Note:* Programs highlighted in bold were among the top ten programs in the 1995 NRC ranking.

listed the top ten programs based on the mean of the high and low scores of the R-Rank in Table 7 as well. As can be seen from Table 7, seven of the ten most productive programs in placement were from the top ten programs of the 2010 NRC ranking, either based on the overall score or the R-Rank. A similar observation can be made about the top ten programs in the ranking based on eigenvalue centrality. Surprisingly, three highly ranked programs from this study were not among the top ten programs in the 2010 NRC ranking: Ohio State, Minnesota, and Kansas (Table 7). We were also surprised that highly rated programs in the 2010 NRC ranking, particularly Boston and Maryland, were not among the top ten programs in the ranking of this study.

To further compare the results of this study with the 1995 ranking, we performed a correlation analysis using six variables: the 1995 NRC rating of geography programs, ranking based on absolute placement productivity, ranking based on relative placement productivity, and each of the program rankings based on the three centrality measures. We conducted the correlation analysis for both the period from 1961 to 2010 and the period from 1991 to 2010. The results of the correlation analysis suggest that program absolute productivity, eigenvalue centrality, relative productivity, and out-degree centrality are all significantly correlated with the 1995 NRC ranking, but in-degree centrality is not significantly correlated with the 1995 NRC ranking (Table 8). Although the 1995

***Table 7*** *Top ten programs from the 2010 National Research Council (NRC) ranking and top ten programs based on absolute placement productivity and scores of eigenvalue centrality*

| 2010 NRC ranking based on overall score (rank) | 2010 NRC ranking based on the mean R-Rank scores (rank) | Absolute productivity (rank) | Eigenvalue centrality (rank) |
|---|---|---|---|
| Boston (1) | UC–Santa Barbara (1) | UC–Berkeley (1) | Ohio State (1) |
| Colorado (2) | Boston (2) | Ohio State (tie for 2) | **Colorado (2)** |
| Maryland (3) | Wisconsin–Madison (3) | **Colorado (tie for 2)** | **Wisconsin–Madison (3)** |
| UC–Los Angeles (4) | Maryland (4) | **Wisconsin–Madison (4)** | UC–Berkeley (4) |
| Penn State (5) | Colorado (5) | **UC–Santa Barbara (5)** | **UC–Los Angeles (5)** |
| Oregon (tie for 6) | UC–Los Angeles (6) | Minnesota (6) | **Penn State (6)** |
| Clark (tie for 6) | UC–Berkeley (7) | **Penn State (tie for 7)** | Washington (7) |
| South Carolina (8) | Penn State (8) | **UC–Los Angeles (tie for 7)** | Minnesota (8) |
| UC–Santa Barbara (9) | Arizona State (9) | **Clark (tie for 9)** | Kansas (9) |
| Wisconsin–Madison (10) | Washington (10) | Kansas (tie for 9) | Arizona State (10) |

*Note:* Programs highlighted in bold were among the top ten programs in the 2010 NRC ranking as measured by a simple average of the S-Rank, research, students, diversity, and R-Rank scores. Programs underlined were among the top ten programs in the 2010 NRC ranking based on the mean of the high and low scores of the R-Rank.

***Table 8*** *Correlations between program placement productivity, centrality of a program, and the 1995 National Research Council (NRC) ranking*

| | 1995 NRC ranking | |
|---|---|---|
| | **Time period of placement data (1960–2010)** | **Time period of placement data (1991–2010)** |
| Absolute placement productivity | 0.867* | 0.881* |
| Relative placement productivity | 0.724* | 0.776* |
| Eigenvalue centrality | 0.791* | 0.756* |
| Out-degree centrality | 0.869* | 0.881* |
| In-degree centrality | 0.209 | –0.050 |

*Spearman's rank correlation is significant at the 0.01 level.

NRC ranking was conducted more than fifteen years ago, and it was based on information about thirty-six rather than the current list of seventy-two programs, the rating of doctoral geography programs based on placement productivity corroborates the 1995 NRC ranking reasonably well. This result echoes findings from other disciplines that objective measures based on placement of doctoral graduates serve as a legitimate indicator for evaluating research doctoral programs (Feeley 2002; Burris 2004; Barnett et al. 2010).

As for the correlation between the results of this study and the 2010 NRC ranking, we calculated the correlations between each of the six variables of this study mentioned earlier against each of the five major ratings in the 2010 NRC ranking as well as the overall rating (Table 9). For each of the five major ratings, a mean of the high and low scores was used in the calculation to obtain the score in that rating to rank the programs before the correlation analysis was performed. As can be seen from the results in Table 9, when the ranking based on the categories of students and diversity is excluded, the ranking from this study significantly correlates with the 2010 NRC ranking to a good degree with the exception of the correlation between eigenvalue centrality and research (Table 9). Among the five major ratings in the 2010 NRC ranking and the overall score, the ranking from this study and the rating based on the R-Rank in the 2010 NRC ranking have the highest correlation coefficients (Table 9).

## Conclusions and Discussions

In summary, we first provided an assessment of the productivity of research doctoral geography programs in the United States based on data about the placement of doctoral graduates over the period from 1960 to 2010. The ten geography programs that had placed the most doctoral graduates in faculty positions in research doctoral geography programs over the fifty-one-year period are, in rank order, UC–Berkeley, Ohio State, Colorado, Wisconsin–Madison, UC–Santa Barbara,

***Table 9*** *Correlations among program placement productivity, centrality of a program, and the 2010 National Research Council (NRC) ranking*

| | Different measurements in the 2010 NRC ranking | | | | | |
|---|---|---|---|---|---|---|
| | **Overall** | **Student** | **S-Rank** | **Research** | **Diversity** | **R-Rank** |
| Time period of placement data: 1960–2010 | | | | | | |
| Absolute placement productivity | 0.432** | –0.027 | 0.418** | 0.366** | 0.132 | 0.515** |
| Relative placement productivity | 0.452** | –0.035 | 0.468** | 0.430** | 0.126 | 0.511** |
| Eigenvalue centrality | 0.349* | 0.112 | 0.333* | 0.239 | –0.019 | 0.422** |
| Out-degree centrality | 0.432** | –0.027 | 0.418** | 0.366** | 0.132 | 0.515** |
| In-degree centrality | –0.113 | 0.333* | –0.139 | –0.288* | –0.018 | –0.166 |
| Time period of placement data: 2001–2010 | | | | | | |
| Absolute placement productivity | 0.509** | 0.072 | 0.479** | 0.355** | 0.124 | 0.578** |
| Relative placement productivity | 0.529** | 0.006 | 0.511** | 0.389** | 0.187 | 0.569** |
| Eigenvalue centrality | 0.357* | 0.220 | 0.321* | 0.156 | –0.020 | 0.418** |
| Out-degree centrality | 0.509** | 0.072 | 0.479** | 0.355** | 0.124 | 0.578** |
| In-degree centrality | –0.234 | 0.373** | –0.261 | –0.448* | –0.141 | –0.290* |

*Spearman's rank correlation is significant at the 0.05 level.
**Spearman's rank correlation is significant at the 0.01 level.

Minnesota, UC–Los Angeles, Penn State, Kansas, and Clark. The most productive programs over the twenty-year period from 1991 to 2010 are, in rank order, UC–Santa Barbara, UC–Berkeley, Colorado, Penn State, Wisconsin–Madison, Ohio State, Clark, Minnesota, SUNY Buffalo, Arizona, UC–Los Angeles, and South Carolina. The top ten programs in relative placement productivity over the twenty-year period are, in rank order, UC–Berkeley, Wisconsin–Madison, Iowa, Colorado, Ohio State, Washington, UC–Santa Barbara, Clark, Minnesota, and SUNY Buffalo.

We then identified programs whose placement productivities exhibited one of four characteristics over the fifty-one-year period: growing, stable, fluctuating, and declining. To accomplish this goal, we examined a program's productivity over four time intervals: 1960 to 1980, 1981 to 1990, 1991 to 2000, and 2001 to 2010. Programs showing the most significant growth in placement productivity are, in alphabetical order of the abbreviations of their names, Arizona State, Clark, and UC–Santa Barbara. Placement productivity in some well-established programs remained stable. Examples of these stable programs are, again in alphabetical order, Colorado, Ohio State, Penn State, UC–Berkeley, UC–Los Angeles, Washington, and Wisconsin–Madison.

Third, we discussed programs that appeared to be more centrally connected with the most productive programs based on the level of exchange through the placement of doctoral graduates with other doctoral geography programs in the nation. Based on the score of eigenvalue centrality of a program on the PhD exchange network, the ten most central programs are, in rank order, Ohio State, Colorado, Wisconsin–Madison, UC–Berkeley, UC–Los Angeles, Penn State, Washington, Minnesota, Kansas, and Arizona State. Fourth, we demonstrated, through correlation analyses, that rating of program productivity as measured through the placement of doctoral graduates resembles the 1995 NRC ranking of research doctoral geography programs reasonably well and significantly correlates with three major ratings—the S-Rank, the R-Rank, and research—in the 2010 NRC ranking. For example, the majority of the highly ranked programs in placement productivity identified in this study were also among the top-rated programs in the 1995 NRC ranking and the 2010 ranking.

Although this study uses an objective measure to assess the productivity of research doctoral geography programs in the nation, it has a number of limitations. Therefore, one should keep these limitations in mind when interpreting the results. First, this study did not include doctoral graduates who were employed in geography programs without a doctoral program, it did not consider people who held faculty positions in PhD-granting departments in other disciplines, and it did not take into account doctoral graduates who worked in public and private sectors. Second, the analysis did not consider the placement of doctoral graduates in doctoral programs outside the United States. Third, this study focused on geography programs in the United States and did not include geography programs in Canada in the analyses, although geography programs in Canada placed many doctoral graduates in geography programs in the United States. Fourth, newer programs were at a disadvantage because these programs only had doctoral graduates in the most recent decade.

In addition, we used data about faculty members who held tenured or tenure-track positions in the seventy-two programs during the 2009–2010 academic year as the baseline information to collect other related data. Faculty retirement and job relocation to positions outside the seventy-two programs over the fifty-one-year period might affect the completeness of the data, and a disproportionate number of retirements and job relocations from graduates of different programs would certainly have an impact on the relative ranking of these programs. Although we have provided information about ranking based on data over the period from 1991 to 2010 to partly offset this problem (Table 3), an analysis using data that include retirement and job relocation information would enhance the reliability of the results. The collection of the data requires significantly more time and resources, however. We decided to leave the collection of the data to future research.

Because the education, training, and placement of doctoral graduates are among the most important missions of a research doctoral geography program, we hope that findings from this study will complement the results

from the 2010 NCR ranking of research doctoral geography programs well. Geography programs that had done well in both the 2010 NCR ranking and the ranking of this study could continue their success and share their experience with other geography programs. Other programs might examine the results of the rankings and identify areas where improvements could be made and elevate the programs to a different level. We recommend that future NRC assessment of research doctoral programs use data about doctoral graduate placement because the objectiveness of the data and the relative easiness in obtaining the data. In addition, prospective doctoral students might use the ranking information from this study in combination with the results from the 2010 NRC ranking to make more informed decisions when planning their careers. ■

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