The Associations between University Rankings and Resource Sharing among Academic Libraries

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abstract: The academic library plays multiple roles in the university, making even a nuanced analysis of service numbers inadequate for assessing the complexity of the library's value and contributions to the university's mission and success. This exploratory study uses social network analysis and a unique interlibrary loan (ILL) data set to examine associations between a library's centrality in ILL networks and the performance of its parent university in *U.S. News & World Report* (USNWR) rankings. The study findings show that two types of network centrality, *outdegree* and *betweenness*, are significantly and positively associated with USNWR rankings. Resource sharing, such as ILL, is not only an essential but also an overlooked function of an academic library that, moreover, relates to a university's ranking and prestige. University administrators should therefore reconsider the "library-as-cost-center" budgetary approach.

Introduction

Academic libraries are one of the largest cost centers in higher education.[1] However, the conception of the library as a cost center in part relies on inadequate models of the value of the academic library. This article describes the use of social network analysis, a theoretical perspective and set of methods that allow mapping relationships and flows between people, groups, or organizations, to identify a library's position in the interlibrary lending (ILL) network. The library's position is, in turn, related to the ranking and hence prestige of its parent university. Operating on the library-as-cost-center paradigm, higher education administrators with an incomplete grasp of the library's value might freeze or even reduce the library budget as they attempt to balance funding for libraries with other competing demands.[2] In this climate,

academic libraries and the Association of College and Research Libraries (ACRL) have made concerted efforts to articulate the value of libraries and their contribution to broader institutional goals and missions in higher education.[3] These efforts broadly fall under the assessment umbrella, and diverse approaches have been undertaken in that vein. These include probes of, for example, the associations between library expenditures and student retention,[4] and links between the use of library materials and grant income.[5] A number of studies in this area focused on the idea of a quantifiable return on investment (ROI), a concept that gained steam with the LibValue project, a three-year study funded by the Institute of Museum and Library Services to explore how libraries create value through teaching and learning, research, and public engagement.[6] More recently, a special issue of the journal *College & Research Libraries* includes studies that take a more inclusive approach to demonstrating the value of the academic library.[7] The articles address, for example, the correlation between library use and student success,[8] aligning library services with the parent institution's learning analytics ecosystem,[9] and a primer on library learning analytics, the gathering of data about students to assess their academic progress and improve learning outcomes.[10]

Collectively, these studies have done much to sensitize higher education administrators that, beyond its role in knowledge production, the academic library has economic and other impacts that affect the university's bottom line. However, there has been a backlash against these efforts to create performance-based indicators to assess the value of the academic library. These reactions range from an exhortation of academics not to participate in the creation of performance indicators[11] to a call for alternative qualitative measures of success.[12] The crux of criticism of the work on ROI and performance indicators is a sense that these studies have been "poorly constructed, ineffectively executed, and naïvely communicated."[13] This implies room for rigorous, quantitative studies that examine the role of the library in institutional success in higher education. Further, systems approaches, such as network science, offer novel ways of examining how the academic library impacts institutional success beyond a straightforward ROI study (for example, every $1 the university spends on collections generates $5 in grant income).

This study undertakes an examination of the association between academic libraries and university rankings by using theories and methods from social network analysis. Specifically, such analysis can enable us to decode the "black box" of relations among academic libraries. Information sharing and other interactions among academic libraries create ripples of influence that are felt within the parent universities, throughout academia, and in broader society. ILL is an

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important means of resource sharing among academic libraries where they interact with each other to meet the needs of their respective users. A significant amount of scholarly work would not happen without ILL or would at least be more difficult.[14] Moreover, the direct association between library collections and ILL activity implies that we can glean meaningful insights about the entire library's impact from an examination of ILL data alone. Considering the long-held belief that the library is the heart of the university, a deeper understanding of ILL activities could lead us to a better understanding of how the library's performance impacts the university's ranking.

Interlibrary Loan (ILL)

ILL plays a critical role in helping the academic library fulfill its mission to support research and scholarship in higher education. Previous work has found significant, positive correlations between ILL activity and research endeavors.[15] Typically, ILL supplements the academic library's collections by obtaining materials from other libraries. Even the most impressive local library cannot possibly hold all the information that the scholars and students it serves need to carry out their work.[16] ILL transactions account for less than 2 percent of academic library expenditures.[17] While ILL budgets are small in absolute terms, ILL transactions can nevertheless be expensive, requiring significant staff time and logistical investment.[18] Thus, many small academic libraries have limited ILL budgets. Moreover, because ILL services are costly, academic libraries tend to make them available only to their well-defined users.[20]

Most studies of ILL costs have focused on single institutions or no more than a handful of institutions, thus limiting their generalizability to a wide range of academic libraries. There are some exceptions. A decades-old survey of 101 academic libraries that were ACRL members (exclusive of those with overlapping membership in the Association of Research Libraries or ARL) found that the costs of ILL transactions ranged from $0.16 to $32.89 with a mean of $5.99.[21] A later study of 30 academic libraries in the Southeast found that ILL lending costs ranged from zero to $25.[22] Not only are there critiques of how ILL transaction costs are computed,[23] but also some studies suggest it may be more cost-effective to purchase materials that have been requested instead of borrowing them via ILL.[24] Finally, even this last approach (also known as "purchase-on-demand") has been criticized for underestimating the true costs of adding these titles to the library's

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collections.[25] The debate on ILL costs does not diminish the central argument in this paper. While interlibrary loan (ILL) is an expensive service, it may have hitherto unmeasured institutional benefits to universities. Accounting for these unmeasured effects of ILL may show that it is more beneficial and cost-effective than thought.

Much of what defines successful ILL transactions happens behind the scenes, thus making the service to appear as a deus ex machina to patrons and even library and university administrators.[26] Come budget time, this could potentially pose a problem to ILL department heads tasked with justifying a costly service embedded in a large

"cost center." Another existential problem for ILL is that it depends on academic libraries maintaining healthy library collections. This means that budget cuts to individual academic libraries reduce the availability of materials for ILL in academia as a whole. Conversely, it means that ILL activity can help us better understand the connections among academic libraries and the implications for universities of the ILL network positions of their respective academic libraries. One important way that academic libraries have a broader impact involves the perceived prestige of universities.

Prospective students are often advised to consider the library as an important factor during the university selection process.[27] Whatever the shortcomings of the "library is the heart of the university" metaphor, it is uncontroversial to contend that, architecturally speaking, the library has come to represent higher education even into the twenty-first century.[28] Traditionally, the size of a university's print collection has been a marker of its status.[29] While that may still be the case today, there is increasing awareness of the role of consortia and networks in filling the gaps in a university's collection. ILL plays an important role in the functioning of these consortia and networks. There is often a direct association between the library's holdings and its ILL activities. Previous work has found strong correlations between collection size (print journals and monographs) and ILL activity.[30] Therefore, a library's ILL activities are a window into the soul of a library's collection and may foreshadow the status or prestige of the parent university.[31]

Prestige and University Rankings

Research on human groups has shown that the pursuit of prestige and power characterizes all societies.[32] While this research has mostly focused on individuals, key findings can be extrapolated to other social actors, including organizations.[33] For example, higher status actors may not only have more influence but also get preferential access to resources.[34]

The perceived prestige of a social group, such as work team, is related to its members' identification with the group and the collaboration among group members.[35] A social group's prestige can also shape the interactions with other actors that are critical to the group's survival by, for example, influencing the group's access to resources.[36] For this study, third-party ratings and rankings in higher education essentially function as markers of a university's prestige. Prestige is important for universities and is related to processes and outcomes that are key to their survival and success. For example, an institution's standing serves to attract prospective students, thus ensuring the university's success and survival.[37] University rankings are often treated as indicators of an institution's academic prestige regardless of inherent biases and limitations in the system.[38] Rankings such as the one by *U.S. News & World Report* (USNWR) are used as a proxy for the university's academic quality by prospective students, especially for national and top-rated universities.[39]

There are valid and well-founded criticisms of USNWR rankings.[40] For example, they negatively impact law school admissions by adding pressure to admit applicants with high test scores at the expense of such considerations as diversity.[41] Similarly, an increase in an institution's ranking is associated with negative enrollment effects for African-American students. The objective of this study is not to validate USNWR rank-

ings. Rather, they are treated as an unavoidable if unfortunate reality of higher education today. Within that limitation, the primary objective of the study is to examine what relation, if any, exists between library performance (ILL network position) and university prestige (USNWR ranking). This connection has vital implications for the university's survival and success. Academic reputation and prestige along with financial affordability are, globally, the two most important college selection criteria.[43] Moreover, the university's prestige is strongly correlated with student retention and support.[44]

For universities, not only does prestige matter immensely,[45] but also there is a documented relationship between the library's

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performance and a university's reputation and prestige.[46] Despite this, little research has investigated the library's impact on the university's standing. There is some evidence that library expenditures correlate with a university's reputation and stature.[47] There is also evidence for statistically significant relations between library print collections and the prestige of academic programs in universities.[48] Finally, prior research has found a correlation between the quality of the library facilities and student choice.[49] Conceptualizing libraries as social actors, academic library expenditures enable individual-level analysis of the association between library performance and university prestige. Richer probes should be possible from a relational perspective, using data on interactions among libraries that enable us to perform network-level analyses of the associations between library performance and university standing. The next section briefly outlines social network analysis and highlights its suitability as a theoretical and methodological approach for understanding ILL interactions among academic libraries.

Social Network Analysis

Social network analysis is the empirical inquiry into the pattern (nature and structure) of the relations between social actors, as well as the pattern of relations at different levels of analysis.[50] Such analysis is both a theoretical perspective as well as a set of methodologies. A basic conception of a network is that it is comprised of *nodes* (actors) and *ties* (relations). Nodes can be individuals, such as people, or collectivities, such as organizations. Ties can differ by such dimensions as whether they are direct ("friends") or indirect ("friends of friends"), or undirected ("A likes B, B likes A") as opposed to directed ("A likes B, B does not like A"). ILL transactions are by nature directed. That is, institution A can borrow from institution B, even while B does not borrow from A. With respect to levels of analysis, most social network analysis studies focus on the egocentric (individuals), dyadic (pairs of individuals), and sociocentric (whole group or network) levels. A number of measures are associated with each level of analysis. Egocentric measures include degree (number of ties between the central or focal node and other nodes) and betweenness (how often the focal node sits on the shortest paths between other pairs of actors). The geodesic (shortest path between two nodes) is an example of a dyadic measure. Finally, density (the actual number of ties in the network

as a proportion of the theoretical maximum number) is the most commonly studied sociocentric measure. This exploratory study focuses on the egocentric level, where the "individuals" in this case are academic institutions.

Networks offer social actors different possibilities and constraints, contingent on the position of the actor. A key insight of the network approach is that actions at one level, such as the individual level, often have impacts that extend to other levels, such as the network level. In this study, we examine the network created by the pattern of ILL borrowing and lending (the ties) among academic libraries (the nodes). Borrowing and lending between libraries (dyadic level) aggregate to the ILL network (sociocentric level). In turn, we can then identify whether an academic library occupies an advantageous position (egocentric level) as reflected by measures of network centrality. Finally, this enables us to examine the association between a library's network centrality and a university's performance on the *U.S. News & World Report* ranking. There are multiple approaches to conceptualizing an actor's network centrality, or position and importance in the network. Each of these measures maps onto different aspects of how the network structure confers advantages or disadvantages to actors. In this exploratory study, we focus on three key measures of network centrality: *outdegree*, *indegree*, and *betweenness*.

With directed data such as ILL transactions, actors differ from one another not just in terms of the number of network connections they have (captured by degree) but also in terms of whether the ties are incoming or outgoing. An actor with many outgoing ties is said to have high outdegree and will likely be influential in the network. For the ILL network, outdegree corresponds to outgoing materials, or lending. An actor that receives many incoming ties is said to have high indegree and will likely have prominence in the network. With respect to the ILL network, indegree corresponds to incoming materials, or borrowing. Finally, an actor that is frequently on the shortest path between other pairs of actors in the network is considered to have high betweenness. By serving a connector or intermediary role, the actor has the potential to link others in the network or even to broker information and other network resources to the focal actor's benefit. For the ILL network, betweenness corresponds to the ability to control or facilitate the flow of ILL materials in the network.[51] Consider the seven fictional libraries A1 through A7 depicted in Figure 1. A line or tie connecting two libraries indicates the presence of an ILL relationship between the two libraries. Arrows pointing at the library indicate incoming materials, while arrows pointing away reflect outgoing materials. Bidirectional arrows represent both incoming and outgoing materials between the two libraries. Therefore, A1 borrows from A5, and A5 lends to A1. However, A5 does not borrow from A1. In contrast, A2 and A5 lend to and borrow from one another. A3 has the most incoming materials and hence the highest indegree. A2 has the most outgoing materials and hence the highest outdegree. Finally, A2 lies on the highest number of shortest paths between other libraries (for example, the paths A1-A2- A3 or A5-A2-A4) and hence has the highest betweenness in the network. Figure 1 illustrates that removal of A2 hinders information flow among the remaining six libraries and cripples the overall network structure. In other words, because actors with high betweenness facilitate or control the flow of information and other resources in the network, they play a critical role in shaping the network structure and relations among actors. Finally, A7 is a library without lending or borrowing ties with any other library in the network.
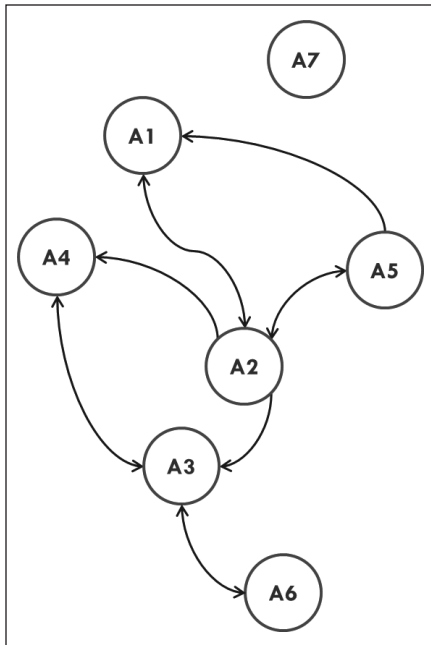
Figure 1. Network graph for interlibrary loan (ILL) transactions among seven fictional libraries. The direction of the arrow indicates whether an ILL item is outgoing (being lent) or incoming (being borrowed).

Theoretical Approach

The USNWR rankings are not merely an indicator of academic quality but also function as markers of prestige for universities. If the library's position in the ILL network is an indicator of its quality, one way in which this may be captured in the USNWR ranking is via the "expert opinion" factor. Specifically, a peer assessment survey is used to determine how a school is regarded by administrators—for example, presidents, provosts, and deans of admissions—at peer institutions.[52] A study of previous respondents of the USNWR peer assessment survey found that library quality was one factor they used to define academic reputation.[53] And somewhat tautologically, USNWR rankings are significantly correlated with future peer assessments.[54]

There are well documented and important relationships between the use of academic libraries and a range of student outcomes, such as graduation, retention, academic achievement, information literacy, and critical thinking.[55] Therefore, it is not surprising that a potential mechanism by which library quality may be correlated with the USNWR ranking is through its potential effects on graduation and retention rates, which account for 22 percent of the rating.[56] Regardless of the mechanism at work for the relationship between library quality and the university's ranking, the central hypothesis in this study is that the library's centrality or position in the ILL

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network is an indicator of the library's quality. That, in turn, should correlate with the university's USNWR ranking.

The three types of network centrality suggest different ways in which the academic library's position in the ILL network may correlate with external measures of institutional status, such as the parent university's USNWR rankings. Specifically, this article hypothesizes that:

H1: The higher the library's *outdegree*, the higher the university's USNWR ranking.

H2: The higher the library's *indegree*, the higher the university's USNWR ranking.

H3: The higher the library's *betweenness*, the higher the university's USNWR ranking.

The hypotheses assume an association between the library's network position and the university's USNWR ranking even though the exact mechanism that drives the association is still unclear.

Data and Methods

Data, Sampling, and Variables

Data

The author obtained raw data on ILL transactions from OCLC for the period 2005 to 2012 for United States and Canadian libraries. While the focus of this paper is academic libraries, an ILL transaction is a dyadic interaction between a pair of libraries that need not both be academic libraries. Assuming no limitations on computational and data storage resources, the optimal ILL network would have included all the libraries that appear in USNWR rankings, as well as all their ILL transaction partners over the study period. For this reason, the ideal scenario would have been to collect the raw data for all ILL transactions in the United States and Canada regardless of whether the libraries were academic or public. However, this approach was not feasible and would have placed undue demands on the OCLC staff responsible for data pulls. Therefore, starting in April 2011, a two-year process of negotiating a more feasible data pull commenced. This included the formal paperwork for data sharing between the University of Michigan in Ann Arbor and OCLC. In May 2013, OCLC shared raw data on ILL transactions in the United States and Canada that covered all key libraries regardless of whether they are academic or public. More specifically, this group of key libraries included all institutions that met the following criteria: (1) academic libraries in universities classified as research universities (very high research activity) according to the 2005 Carnegie basic classification; (2) academic libraries that are members of the ARL; (3) U.S. public libraries serving over 100,000 people; and (4) any Canadian public library. There were 398 key libraries that met at least one of the four criteria. However, pulling data on these key libraries also captured data for all their ILL transaction partners regardless of whether they met any of the four criteria that defined the target population. Importantly, the study data enabled an examination of the association between rankings and the library's performance among research universities, which are especially sensitive to the impact that rankings have on revenues.[57]

The raw data contain roughly 67 million ILL transactions across all libraries including the key libraries (N = 398) and the thousands of their ILL transaction partners (see Tables 1 and 2). Table 1 summarizes the number of ILL transactions (items exchanged) and relations (borrowing or lending between pairs of libraries) among the institutions in the data set. Table 2 shows that, including the core libraries, the number of libraries that showed up in the ILL transaction data ranged from 6,844 to 7,414 in the eight-year study period 2005 to 2012.

Study Sample

The sample for this exploratory study is the much smaller subset comprising the universities that placed in the top 50 of the *U.S. News & World Report* (USNWR) national rankings for the period 2005 to 2012. This group of universities is ideal for analysis of the relationship between university prestige and library performance because they not only are more sensitive to how rankings impact them but also dominate the ILL landscape in North America. For example, of the 3,793 institutions that participated in the 2012 Academic Libraries Survey, only 285 or 7.5 percent were classified as "Doctoral/Research." This small group, however, accounted for 57 percent and 55 percent of all ILL lending and borrowing, respectively.[58] Further, the sensitivity to rankings is higher for top-ranked national universities, most of which are research-intensive institutions.[59] More specifically, the analysis focuses on the 39 institutions that: (1) are in the USNWR rankings and (2) are members of the ARL. There is a significant overlap between the top-rated national universities in the United States and ARL membership. Established in 1932, the ARL is comprised of comprehensive research institutions in the United States and Canada. Most ARL members are research-intensive universities. However, some members are federal or public libraries, for example, the Library of Congress, Boston

Table 1.

Number of interlibrary loan (ILL) transactions and relations among libraries, 2005–2012

Year	Transactions	Relations
2005	5,379,323	808,376
2006	9,067,414	1,098,267
2007	9,060,787	1,119,529
2008	9,054,133	1,135,612
2009	9,228,531	1,152,347
2010	8,783,002	1,114,854
2011	8,244,483	1,072,580
2012	7,833,996	1,043,717
Total	66,651,669	8,545,282

Table 2.
Number of institutions in the interlibrary loan (ILL) network yearly, 2005–2012

Year	Number of institutions
2005	6,844
2006	7,147
2007	7,313
2008	7,354
2009	7,345
2010	7,301
2011	7,303
2012	7,414

Public Library, and New York Public Library. The prominence of ARL members in the research landscape in the United States and Canada means that they play a major role in ILL activities in North America.

Variables

The dependent variable "USNEWS Rank" captures a university's or college's position in the *U.S. News & World Report* annual top 50 list for the years 2005 to 2012. For this variable, a lower score is preferable to a higher one. That is, a university would rather have a rank of 1 than 25.

The independent variables "Outdegree," "Indegree," and "Betweenness" are measures of network centrality (see the descriptions in the section "Social Network Analysis") that were generated from the ILL networks for the study period 2005 to 2012. Note that the networks are generated using all institutions in the data (key libraries plus all their ILL transaction partners). Following the computation of the network centrality measures, the variables for the libraries in the study sample are retrieved.

The control variable "ARL Index" is the ARL Library Investment Index score that was assigned to ARL members in the study period 2005 to 2012. The ARL Library Investment Index was continuously published in various forms by the *Chronicle of Higher Education* between 1999 and 2016.[60] The four factors used to construct the index were (1) total library expenditures, (2) salary expenditures, (3) materials expenditures, and (4) professional plus support staff.[61] The index not only captures investments in the library but also can serve as a proxy for the financial and institutional environments at the parent university. For example, given that libraries are major cost centers, there is usually a positive correlation between library expenditures and the university's budget.

Methods

This exploratory study employed two primary methodological approaches: social network modeling and analysis, and cross-section time-series regression modeling using fixed-effects linear models.

Social Network Analysis

Using the aggregated dyadic transactions, yearly lists of the edges (ILL transactions) between pairs of libraries were generated in which a list had three columns: lender, borrower, and number of transactions. The next step was to feed these yearly edge lists into the Ucinet network analysis software.[62] Using Ucinet's built-in routines, the edge lists were used to generate the three measures of network centrality in this study: outdegree, indegree, and betweenness.

For each year, the author used Ucinet's companion network visualization software, NetDraw, to generate graphs for ILL networks in the study period.[63] Almost all the graphs had over 7,000 nodes (see Table 2), which made it challenging to read or discern the network structure of the yearly ILL networks. For example, Figure 2 shows the ILL network for the year 2005. Except for a few isolated pairs of libraries on the periphery of the graph, most libraries were in the *main component* of the network (the big ball of nodes in the center of Figure 2). A component is any part of the network where there are no disconnected nodes. The main component is the largest component of a network.
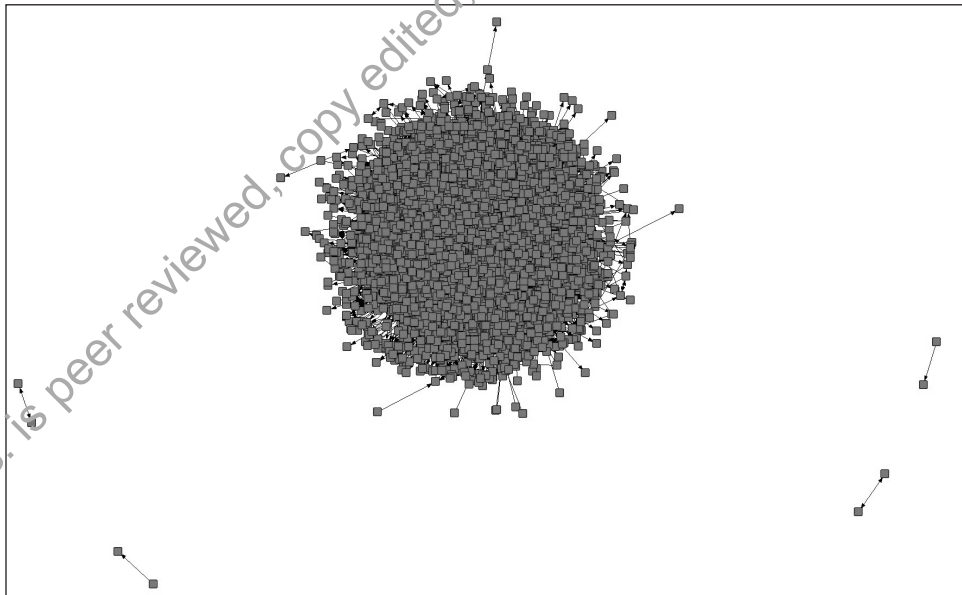

Figure 2. Interlibrary loan (ILL) network among libraries for the year 2005 (nodes = 6,844; ties = 808,191). Except for a few isolated pairs of libraries on the periphery of the graph, most libraries are in the big ball of nodes in the center of the figure. Note the directionality of ILL ties as shown by the arrows; a library might lend to or borrow from another library, or do both.

Regression Modeling

Cross-section time-series fixed-effects linear models were used to examine the relationship between the three centrality measures and USNWR rankings over the study period. The variables "Outdegree," "Indegree," and "Betweenness" are highly collinear (r = 0.867–0.884). Therefore, a single model with all three measures of network centrality would have suffered from multicollinearity, such a high degree of correlation between supposedly independent variables that the contribution of each variation in the dependent variable could not be determined. Therefore, three different regression models were run, one for each measure of network centrality. For each network measure, fixed effects models were run with no time-invariant variables (such as ARL membership). The decision to use fixed-effects over random-effects models was further supported by a statistical procedure known as Hausman specification tests, which indicated that the former were preferable to the latter. The models are specified as follows:

(*Equation 1*)

Where:

Y_{it} → *i = USNWR ranking, t = time*

α_i → *(i = 1 . . . n) is the unknown intercept for each institution (n institution-specific intercepts)*

X_{1t} → *Network centrality, t = time*

X_{2t} → *ARL Index, t = time*

u_{it} → *error term*

The models were examined for potential *heteroscedasticity*, the circumstance in which errors vary with the effects being modeled, using standard econometric techniques.[64] Heteroscedasticity can lead to model misspecification, invalidating statistical tests of significance.[65] Steps such as the use of clustered robust standard errors were undertaken to account for heteroscedasticity in the models.

Results

The descriptive statistics for the raw or unstandardized variables shown in Table 3 indicate that the independent variables are on different measurement scales (see, for example, the minimum and maximum values of "ARL Index" compared to "Outdegree"). This makes it hard to directly compare the variables with respect to their association with "USNEWS Rank." Therefore, the independent variables were standardized to have a mean of zero and a standard deviation of one. The resultant regression model coefficients are in terms of standard deviations and are easier to compare with each other.

The results shown in Table 4 indicate that "Outdegree" and "Betweenness" are significantly associated with "USNEWS Rank," lending support for hypotheses H1 and H3. However, "Indegree" is not significantly associated with "USNEWS Rank," indicating no support for hypothesis H2. The R-squared values for the models suggest that network centrality and the ARL Investment Index explain at least two-thirds of the variance in "USNEWS Rank."

Table 3.
Variable summary statistics and correlations (significant at p < .01)

Variable	Mean	SD	Min	Max	1	2	3	4	5
USNEWS Rank*	25.516	14.944	1	50	1.000				
Outdegree†	1,329.393	6,088.694	0	149,483	0.410	1.000			
Indegree‡	1,317.887	5,796.858	0	113,074	0.388	0.888	1.000		
Betweenness§	9,834.334	56,678.390	0	1,163,194	0.440	0.868	0.873	1.000	
ARL Index#	0.102	1.119	−1.374	6.175	−0.402	0.090	0.156	0.085	1.000

*USNEWS Rank reflects a university's or college's position in the *U.S. News & World Report* annual top 50 list from 2005 to 2012.

†For the interlibrary loan (ILL) network, outdegree equals outgoing materials, or lending.

‡Indegree corresponds to incoming materials, or borrowing.

§Betweenness measures whether an academic library is a key connector or intermediary in the ILL network.

#The Association of Research Libraries (ARL) Library Investment Index, published from 1999 to 2016, ranked libraries based on a combination of total expenditures, salary expenditures, materials spending, and number of staff.

The higher the "Outdegree" of an academic library in the ILL network, the lower (and better) the "USNEWS Rank" of the parent university. This association is statistically significant at $p < .01$. Similarly, the higher the "Betweenness" of an academic library in the ILL network, the lower the "USNEWS Rank" of the parent university. This association is statistically significant at $p < .05$. Note that, while not statistically significant, the association between "Indegree" and "USNEWS Rank" is also positive.

The coefficients in Table 4 also illustrate that "Betweenness" has a relative effect on "USNEWS Rank" that is nearly double that of "Outdegree." Finally, from Table 4 we can see that the "ARL Index" control has a statistically significant association with "USNEWS Rank" that is consistent in terms of the relative effect size across the three models. More specifically, the higher the "ARL Index," the lower the "USNEWS Rank."

Discussion, Limitations, and Future Directions

The results suggest that there is an association between an academic library's ILL network position (library performance) and the parent university's USNWR ranking (institutional prestige). The significant association between an academic library's centrality in the ILL network and the university's USNWR ranking suggests that top administrators in academia may want to reconsider their approaches to library budgeting and rethink the library-as-cost-center paradigm. The study findings suggest that the academic

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library may play a larger role in the success of the university than previously acknowledged. Beyond its obvious mission to support learning and knowledge generation and dissemination for its community of users, the academic library likely contributes to the university's success and survival in other, unmeasured ways. The study findings suggest that more research is needed to examine whether there are other positive and uncaptured effects of investing in the library. Inquiries of this nature could give us a more holistic picture of the value of the academic library beyond its more obvious or better understood missions. Additional evidence that the academic library's performance is significantly associated with such outcomes as prestige may even help transform the library-as-cost-center paradigm in higher education.

The study findings, though exploratory in nature, also suggest that, while centrality in the ILL network may confer hitherto uncaptured benefits to the parent university, the different types of network centrality are not the same. High "Outdegree" signifies that the library is a net giver or lender and is positively and significantly associated with "USNEWS Rank." In contrast, high "Indegree," which indicates that the library is a net taker or borrower, is not significantly associated with "USNEWS Rank." Capturing the complexity of the organizational and interorganizational decisions and processes that lead to an institution being a net giver or taker in the ILL network is beyond the scope

Table 4.

Association between network centrality and USNWR rankings, 2005–2012

Variable	USNEWS Rank*	USNEWS Rank	USNEWS Rank
Outdegree†	-0.0202‡		
	(0.00416)		
Indegree§		-0.00759	
		(0.00601)	
Betweenness#			-0.0383‡
			(0.0127)
ARL Index‖	-0.586‡	-0.584‡	-0.589‡
	(0.0697)	(0.0672)	(0.0700)
Constant	0.444‡	0.379‡	0.543‡
	(0.0575)	(0.0675)	(0.101)
R-squared	0.674	0.661	0.675
Number of libraries/universities	39	39	39
Total number of observations	374	374	374

Robust standard errors in parentheses

Note: All variables are standardized.

*USNEWS Rank reflects a university's or college's position in the *U.S. News & World Report* annual top 50 list from 2005 to 2012.

†For the interlibrary loan (ILL) network, outdegree equals outgoing materials, or lending.

‡ $p < .01$. The *p*-value gives the likelihood that any effect seen in the data, such as a correlation, might have occurred by chance.

§Indegree corresponds to incoming materials, or borrowing.

#Betweenness measures whether an academic library is a key connector or intermediary in the ILL network.

‖The Association of Research Libraries (ARL) Library Investment Index, published from 1999 to 2016, ranked libraries based on a combination of total expenditures, salary expenditures, materials spending, and number of staff.

of this study. Suffice to note that there are differences between the giver and taker roles, meriting additional work to disentangle the causal factors that drive these decisions and processes. Lastly, of the three centrality measures, "Betweenness" had the highest relative effect magnitude. High "Betweenness" captures whether an academic library is a key connector or intermediary in the ILL network and is positively and significantly associated with "USNEWS Rank."

More research is needed to ascertain whether high "Betweenness" is primarily shaped by: (1) internal, organizational factors in the university such as the library budgeting process, or (2) external, structural factors such as tie-ins with academic library associations. Future studies could shed light on the interplay between the factors at multiple levels that shape the extent to which an academic library is a connector in the ILL network.

There are three major limitations to this study that merit future attention. The first is that the ILL data are not available beyond the year 2012. In the period since 2012, several developments have impacted how users interact with academic libraries. These include changes in the landscape of publishers and vendors; the rise of fake news, false stories spread to influence political views; and even the increasing importance of learning analytics.[66] More current ILL networks are needed to address these changes, some of which will likely be magnified significantly as a result of the COVID-19 pandemic.[67] The second limitation is that, even with the cross-section time-series models used in the study, more work is needed to disentangle the direction of causality between the library's performance and the university's ranking. Just as there is a tautological relationship between USNWR rankings and future peer assessments,[68] there is likely endogeneity—in statistics, a correlation between the independent variable and the error term—between indicators of library performance and university rankings. Finally, the third limitation is that the ARL Investment Index was discontinued in 2016. Thus, running robust time-series or panel models beyond 2016 is contingent on a reconstruction of the index assuming availability of the same type of data that were used to construct the original index.

This exploratory study demonstrates the utility of applying systems approaches such as social network analysis to examine the complexities inherent in assessing the value of the academic library to the university. In doing so, it also provides fodder for future research. For example, could we unmask the mechanisms that drive whether a library is a giver or connecter in the ILL network? Are there other outcomes of importance to the university that are impacted by whether the library is a giver or connector?

Conclusion

This exploratory study suggests that research on the value of the academic library should expand its scope to consider other dimensions beyond those that constitute the traditional mission of the academic library in the university. Failure to capture these types of impacts may understate the importance of the academic library. Better and more nuanced approaches to holistically capture the value of the academic library may lead to a reconsideration of the predominant thinking among university administrators of the library as (mostly) a large cost center.

With respect to the roles and activities of the academic library in the university, this exploratory study suggests that the library might do more than meets the eye, and this should shape future efforts to capture the value of the academic library. The focus on ILL in this paper illustrates that a relatively straightforward service that academic libraries provide to their communities may in fact have broader impacts beyond the library's traditional mission. Indeed, performance in the ILL network is positively associated with the parent university's USNWR ranking (hence prestige). Specifically, giving or lending and connecting or facilitating are positively related to the university's ranking, while taking or borrowing is not.

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