Peer Effects in Tournaments for Status:
Evidence from Rank Dynamics of U.S. Colleges and Universities*

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Abstract

Individual outcomes in tournaments for status result not only from participants' own qualities and behaviors, but also from those of their most proximate peers. In this article, we take an alter-centric view of status dynamics, examining the effect of peers' perceived quality on future changes in a focal organization's status. Utilizing the yearly tournaments created by *U.S. News & World Report's* rankings of national colleges and universities, two competing predictions are investigated. The first is that peer' advances in perceived quality impair the future status of a focal school, reflecting inter-school competition for finite resources and rewards. The second is that peers' improvements incite a focal school to make cosmetic or material adjustments, leading to an increase in its status. Peers are defined in two ways: by proximity in the prior iteration of the tournament and by network-based structural equivalence. Using fixed effects models predicting future changes in annual *USN* ranks, we observe opposing forces at work, depending on the type of peer exerting influence. When peers identified by prior rank proximity improve in perceived quality, they exert status-eroding effects on a focal school. Conversely, when structurally equivalent peers in the college-applicant market show improvement, the focal school subsequently increases in status. We examine the mechanisms responsible for this divergence by focusing on the bases of each type of peer-affiliation, presenting interaction effects that highlight the contextual conditions that shape the influence of peers on status change. Future directions for research on peer effects and status are discussed.

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"The pressure is real. God forbid you go down in those numbers." - Former Dean of Admissions, Pomona College as quoted in Pérez-Peña & Slotnik (2012)

How do peers affect positional changes in status hierarchies? In one sense, the response is *profoundly*: status is, by definition, context-specific and relative. An individual or corporate actor only has status inasmuch as other actors recognize that status in a differentiated hierarchy and do not occupy that status position themselves. Yet remarkably little is known about the mechanisms or even the directionality of peer influence on status mobility. Consider how peers might quite differently affect holders of status in almost any hierarchy—for example, high school students vying for recognition (Bearman, Moody, and Stovel 2004), gang members striving for respect (Bourgois 2003), or schools reaching for better rankings (Sauder and Espeland 2009). In all such domains, worthy peers can certainly cause status decline. When competitive pressure is too great, either an inability to match peers' actions or a begrudging acceptance of usurpation will push a given status-holder down. Equally possible, however, is the chance that encroaching peers incite a focal actor to make strategic improvements, setting off a chain of events that raise that actor's status. Either way, in status hierarchies, where positions are deeply desired and often seized at others' expense, peers necessarily loom large. Examining peer effects is therefore essential for status research.

Scholarly work relevant to status dynamics, however, has given relatively scant attention to peer effects. The greater part of prior research has, at least implicitly, taken a predominantly egocentric view of status growth and decline: changes in status are generally attributed to shifts in a focal actor's characteristics and behaviors. For instance, even in Podolny's (1993) strongly relational model, an investment bank's changes in status are ultimately thought to have their provenance in prior shifts in the quality of that bank's products. Other studies have similarly adopted an actor-level lens. At an individual level, a person's status accrual has been traced to his or her acts of conspicuous consumption (Veblen 1899), self-sacrificial behavior (Goode 1978), and success in amassing credentials (Collins 1979). At an organizational level, Espeland and Sauder (2007) have brought into theoretical focus the various strategic actions educational institutions pursue to bolster their standings in the context of public rank-based status orderings.

While these lines of research have yielded many important insights, in this paper we depart from earlier work by viewing the antecedents of status change through an *alter-centric* lens. In doing so, we draw inspiration from Sauder, Lynn, and Podolny's (2012, pp. 9-11) contention that "transformations in actor-level characteristics are not sufficient or satisfying explanations of status change... however, zooming out for a wider view of status activity at the field level of analysis offers a compelling alternative approach."

The wider, alter-centric perspective we pursue involves examining the impact of the perceived quality of a focal actor's peers in a prominent tournament: the one played out by nationally-focused American colleges and universities in *U.S. News and World Report's* (henceforth "*USN*") annual undergraduate rankings. Using this tournament as our empirical site, we utilize the *USN* rank as our indicator of status, and we capture peer schools' perceived quality through weighted-average SAT scores, which provide nearer peers with larger weights. Given the multiplex nature of competition in higher education, we identify a focal school's peers on two distinct dimensions. One is proximity in lagged rankings. For example, in table 1, Bates' close rank-based peers in 2005 were Bryn Mawr and Oberlin. The second dimension is proximity in the previous year's college-applicant market. For instance, as indicated by the directed ties in the sociogram shown in figure 1, Stanford and Cornell are peers—despite being thousands of miles apart—because they cited, and were cited by, a similar set of other schools as institutions to which their own students also applied.[1] Reframing our general motivating question in light of the particular features of our setting, the specific empirical question we address in this paper is the following: what is the within-school effect of peer schools' weighted-average SAT scores on a focal school's future change in *USN* rank?

[Table 1 and figure 1 about here]

Our strategy for yielding theoretical insights as we address the question may seem unconventional. We do not lead with a theory section that culminates in closely related hypotheses. We instead parsimoniously sketch reasons for two competing hypotheses about peer effects in status contests that we believe to be equally compelling. Results from initial empirical tests of these two predictions guide us to further analyses that reveal mechanisms underlying the peer effects we observe. Using these findings as our foundation, we then conclude by discussing implications and questions that we believe must inform future research on status dynamics.

Going back to our initial imagery on directionality, the first hypothesis we consider is an ecological prediction. This is consistent with portrayals of contests for status as zero-sum games (Bothner, Kang, and Stuart 2007; Milner 1994), in which peers' advances weaken an actor's subsequent standing in the tournament. To take an example from outside our empirical setting, consider Roger Federer's descent from the class of the tennis world: persistent peer onslaughts from Rafael Nadal and Novak Djokovic brought displacement even as Federer kept his skill level high. Our second prediction is one of contagion. This alternative

[1] In 2005, Cornell and Stanford jointly cited Harvard, Princeton, and Yale, and were both cited by Brown, Harvey Mudd, and MIT.

corresponds to an image of worthy competitors inciting a focal actor to improve in status. To draw another example from tennis, intense local rivalry between Bjorn Borg, John McEnroe, and (entering later) Ivan Lendl triggered an upward spiral for all three. In turn, this trio displaced the older guard, who had previously held a lock on the top ranks.

While the premise that status is, by construction, inherently peer-based is a particularly compelling motivation for focusing squarely on peer effects, further motivation springs from the realized consequences of the *USN* phenomenon itself. One of the most striking features of American higher education is the extent to which its denizens are perennially caught up in the *USN* "rankings craze" (Lovett 2005). College presidents are thought to "live and die" by *USN* ranks (Stecklow 1995) while their administrators "obsess over every incremental shift on the rankings scoreboard" (Pope 2012). Accordingly, peer schools' encroachments appear to be at the root of many consequential outcomes beyond just changes in rank. In particular, after experiencing an ecological effect, an embattled school's alumni make fewer donations, its students and faculty join different institutions, and administrators are fired (Sumner 2005). Likewise, when motivated by a contagion effect, a focal school may pursue a wide array of responses, ranging from investments in costly (and unnecessary) new buildings (see Luzer 2010) to "enrollment management" programs (Hossler 2004). These maneuvers serve as bootstraps to a better rank. Consequently, investigating peer effects among schools contending for ranks is important not just for contributing to an alter-centric etiology of status change. Emphasizing peers also has the potential to shed new light on intriguing organizational behaviors in an empirical setting that has long been of central interest to sociologists (Stevens, Armstrong, and Arum 2008).

Contrasting Theoretical Arguments

Ecological Peer Effects

Various lines of research strongly suggest that an increase in peer schools' perceived quality will diminish a focal school's future *USN* rank. Work from fields as diverse as the sociology of science, organizational ecology, and models of job vacancies supports this contention and is predicated on a strongly alter-centric view: mobility in any contest is a deeply inter-dependent process, involving close coupling among nearby actors. For instance, Merton (1968) observed that a scientist with comparable traits, but slightly inferior status, to a proximate peer will be subjugated in their competition for higher standing. Using a metaphor that distills the "relatively inexpansible" (Milner 1994, p. 34)—and thus ecological—nature of tournaments for status, Merton described two scientists jointly at risk of election to the elite 40-member French Academy: while one gains entry, the other is shunted into the "41st chair." This position represents a dishonorably lower rank described as "an artifact of having a fixed number of places available at the summit of recognition."[2] While the scientific careers in Merton's metaphor of course differ in scale and scope from schools jockeying over time for yearly *USN* ranks, the general implication for the latter context is clear: when peers are especially proximate on a relevant dimension, one's gain equates to another's loss.[3]

Research in organizational ecology, particularly work focused on the concept of the niche

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[2] In a related vein, Azoulay, Reschke, and Stuart (2012) examine the citation trajectories of articles authored by life scientists. These scientists' articles are paired in a matched sample with articles authored by peers who were recently honored as Howard Hughes Medical Investigators. Once this honor is bestowed, they find that citation rates plunge for un-treated papers (i.e., those written by non-HHMI authors), and that the downward pressure on a focal paper's citations gets stronger the more its author's research profile overlaps with the award-winning scientist's profile in the pair. In this sense, the phenomenon of the 41st chair, with its related implications for peer effects, can seem almost ubiquitous.

[3] Research in the sociology of science is also broadly consistent with other work that has taken a step further by focusing explicitly on the mechanisms that maintain status. These studies highlight better-ranked individuals' conscious recognition that the preservation of their status gains logically requires keeping a set of lower-ranked individuals in a state of perpetual status deprivation. Examples of such work includes Frank's (1995) finding that elite individuals in effect compensate low-status to remain present and Painter's (1976) historical account of white southerners' opposition to African-American's efforts to abandon the existing status order by migrating to Kansas.

(Carroll and Hannan 2000; Hannan and Freeman 1989), points in the same theoretical direction. Although the niche in a market setting (Freeman and Hannan 1983; Péli 1997) is of course not perfectly analogous to a position or rank in a status hierarchy (Bothner et al. 2007, pp. 211-13; Podolny 1993, pp. 830-835), niches and ranks share important properties. Both correspond to bundles of scarce, desirable resources, though these underlying resources typically differ in nature. Specific examples of the (often tangible) resources that constitute a market niche include access to particular individuals involved in voluntary associations (McPherson 1983) or customer segments targeted by for-profit companies. The (usually intangible) resources that undergird a status rank can be positive appraisals from peer organizations (Espeland and Sauder 2007), acts of deference from collaborators (Stuart 1998), or, in our empirical setting, the matriculation decisions of high-scoring students.

Following Podolny and Phillips (1996), if we view status as a "stock" built from highly stratified "flows" of recognition, then as a focal school's peers siphon these flows away (i.e., as they successfully net higher-scoring students), the focal school, whose rank is founded on these status-conferring flows, will experience status decline. In this sense, empirical findings in the ecological tradition—particularly those documenting the negative performance-related consequences of niche overlap—carry immediate implications for understanding the peer-based antecedents of status change. Given the wealth of earlier research establishing the inauspicious effects of localized rivalry on organizations' life chances (Amburgey, Dacin, and Kelly 1994; Podolny, Stuart, and Hannan 1996), it is plausible to anticipate observing similar competitive processes at work in contests for status ranks.

Vacancy-based models of job mobility (Chase 1991; Stewman 1986; White 1970) offer further support for expecting an ecological effect in the context of *USN* rankings. The basic insight of this stream of work—that “vacancies create opportunities for mobility” (Rosenfeld 1992, p. 43)—is particularly valuable when considering the antecedents of positional shifts in rank-based status hierarchies. Various kinds of workers, ranging from clergy (White 1970) to managers of psychiatric institutions (Abbott 1990), are known to have their mobility chances expand as incumbents of higher-level jobs vacate these jobs. In similar fashion, a focal school should ascend (or descend) in *USN* rank as its peers fail to attract (or succeed in attracting) coveted incoming students.

Importantly, these vertical movements need not result from purely structural factors, as when the holder of a desirable position leaves and a lower-ranked contestant quickly fills the resulting void. Such movements can also result from agentic factors: the *perception* of expanded opportunity in the wake of a vacancy (Halaby 1988; Stolzenberg 1988) can activate search and trigger parallel efforts to move ahead in status. Obversely, the perception of an unfavorable opportunity structure may weaken motivations to advance (cf. McAdam 1982, pp. 40-51, 191-92). Consequently, going beyond purely structural models, research on vacancies implies that peer schools may also affect a focal school’s calculus of the opportunities to advance in rank and associated effort levels.

Like research in the sociology of science emphasizing the tightly intertwined architecture of status positions, and similar to ecological work focusing on the competitive consequences of niche overlap, research on job vacancies also points clearly to an ecological prediction in our empirical setting: a chosen school’s subsequent *USN* rank will decline as that school’s peers increase their student-body SAT scores.

Contagious Peer Effects

Yet other streams of research—most notably work on relative deprivation (Walker and Smith 2001) and models of competition in the sociology of markets (Barnett 2008; White 1981, 2002)—suggest just the opposite prediction. This work implies that an increase in the perceived quality of a focal school's peers will prompt a *favorable* shift in the focal school's future *USN* rank. From this alternative viewpoint, peers' encroachments prove contagious. They have the (likely unintended) effect of forcing adaptive responses, which in our empirical setting can take two main forms: *cosmetic* or *material* (cf. Espeland and Sauder 2007, p. 6-7).

As an example of a cosmetic response, a school, anxious over a potential slip in rank, initiates new marketing and public relations campaigns, including informal lobbying and "mailings" intended to affect peers' appraisals and thus its *USN* rank (de Vise 2010). The president of Colby College commented on the prevalence of such actions: "perhaps the time has come for us to admit that we are trying to work within a system that encourages us to skew our work toward improving our performance in the rankings rather than focusing on our core educational missions; [we] deploy teams of people to squeeze each ranking data point until it screams, rather than take all possible measures to find students who seek—and will truly benefit from—the distinctive experience we each have to offer" (Adams 2012, p. 1). Cosmetic responses to peer encroachments are just as he suggests: not aimed at improving "core educational missions," but rather aimed at moving the needle on non-core elements of university life that *USN* weights heavily in its rankings methodology.

Conversely, as an example of a material response, a school tightens relations with well-heeled alumni, and it takes steps to enhance its current students' on-campus experience via reduced class sizes, greater student retention (Farrell and Van Der Werf 2007; Pope 2012), and the recruitment of higher-scoring students via merit scholarships. Such steps are organizationally enhancing and not merely cosmetic measures. These maneuvers importantly alter the organization in ways relevant to both its *USN* rank and its general appeal to students and faculty.[4]

Work informed by the concept of relative deprivation (Burt 2010; Merton and Rossi 1968; Stouffer et al. 1949) strongly supports the contention that peers play an important role in prompting these kinds of organizational responses. According to this research, individuals adjust their attitudes and conduct in response to their standing relative to a reference group. When an individual (or group) compares unfavorably to peers, feelings of envy arise, and corrective actions follow. Examples of such reactions, depending on context, include adoption of new technology (Burt 1987), emigration (Stark and Taylor 1989), and prison rioting (Useem and Kimball 1989). The threat of deprivation at the hands of high-performing peers has even been shown to drive efforts for improvement among collegial, non-competing peers. In their extensive study of industry peer networks, Zuckerman and Sgourev (2006) found that non-competing peers (e.g. auto retailers serving different local markets) were nonetheless motivated to outstrip each other on an array of dimensions. The implications for the present context are clear: as peer schools move up in perceived quality, a focal school's administrators experience a dose of "status anxiety" (de Botton 2005) and accordingly seek to alleviate that anxiety with a higher rank.

Core elements of White's (1981, 2002) theory of markets as role structures are also in line with

[4] Our distinction between *cosmetic* and *material* need not imply that material responses are normatively preferable to cosmetic ones. Many substantial organizational changes, particularly shifts in study-body composition, may counter schools' stated missions and (depending on one's values) work against social welfare more broadly defined. Pope (2012, p.1) critiques the process of (mis)allocating financial assistance to "high-scoring students who don't actually need the money [by schools] motivated at least partly by the quest for rankings glory." Leonhardt (2010, p. 1) argues that the "biggest flaw with the famous *U.S. News & World Report* ranking is that it largely rewards colleges that enroll highly qualified (and, typically, affluent) students, regardless of how much those students learn while on campus." More generally, as Gioia and Corley (2002, p. 109) argue, quoting Meyer and Gupta (1994), when institutions "work only toward those goals that are measured, at the expense of valued but unmeasured goals, the process becomes a prime example of 'perverse learning'."

a contagion prediction.[5] Salient in White's (1981, p. 518) model is the contention that peers, not customers or suppliers, are the primary sources of influence in market settings: "I argue that the key fact is that producers watch each other within a market. Within weeks after Roger Bannister broke the four-minute mile, others were doing so because they defined realities and rewards by watching what other 'producers' did, not by guessing and speculating on what the crowds wanted or the judges said." Importantly, top colleges and universities often exhibit the same myopic focus on each other. In particular, although administrators almost invariably express their institutional missions in the pacific terms of service and contribution to their students and to society, the perennial participation of nationally ranked schools in an "arms race" for status (Sauder and Espeland 2009, pp. 74-75) means instead that their most important audience is *themselves*.

Barnett's (2008) model of the Red Queen competition offers similar insights. According to this line of research (see also Barnett and Pontikes 2008; Barnett and Sorenson 2002), exposure to interorganizational competition brings the benefits (for survivors) of stronger capabilities and correspondingly greater life chances. Organizations as varied as banks and software manufacturers have been found to adapt and grow more viable as a result of braving peer-on-peer competition (Barnett 2008). This is because peers' advances compel a target organization to engage in search, innovation, and other forms of adaptive learning. By contrast, organizations whose market positions are differentiated—those whose would-be peers are either at a comfortable distance or, if nearby, fail to apply competitive pressure—are disadvantaged, as they lack motivating external pressure (see also Hirschman's (1970) discussion of the lazy monopolist).

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[5] Sociological portrayals of market processes complement research on relative deprivation in an important connection: while both streams contribute to an alter-centric perspective, work on relative deprivation places disproportionately greater emphasis on how peers incite new courses of action by inducing strong attitudinal responses. Conversely, research on markets takes a "cool" rather than a "hot" (DiMaggio and Powell 1991, p. 15) approach to modeling inter-organizational monitoring. In these models, a focal organization primarily learns and adapts to the new external standards set by rival firms, more than they launch emotionally-laden adversarial responses.

Moving from these empirical settings to schools striving for *USN* ranks, the prediction implied is one of competitive contagion. Together with research on relative deprivation, Barnett's and White's models point precisely to an alternative hypothesis in which peer schools' improvements have the effect of pushing a focal school upward in the hierarchy of ranks.

Empirical Setting and Measurement of Peer School Covariates

To evaluate these alternative hypotheses, we examined how peer schools' weighted-average SAT scores affect a focal school's year-over-year change in *USN* rank from 2006 through 2012. Three main features of *USN* rankings during this multi-year timeframe make our empirical site particularly attractive for addressing the question of how peers affect positional changes in status.[6] First, rankings of national colleges and universities, posted annually in *USN*'s *Best Colleges* issue, create a series of yearly contests for organizational status in which the consequences of peer schools' lagged shifts in perceived quality can be explored with precision.[7] Importantly, these yearly contests exhibit enough churn (Gottlieb 1999) to provide an interesting arena for status dynamics, yet are sufficiently stable (Keith 2001) to reflect meaningfully a reality felt by participating schools.

Second, each year, *Best Colleges* also reports virtually every school's 25th-75th percentile SAT

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[6] A diverse array of other companies (see, e.g., Volkein and Sweitzer 2006) also publishes rankings of undergraduate programs; all differ in their methodology and ultimate hierarchy. These include *Barron's*, *College Prowler, Peterson's*, *Fiske*, *Forbes*, *Kiplinger's*, *Smart Money* ("the best colleges for making money"), *Sports Illustrated* ("top jock schools"), *The Princeton Review*, and *The Washington Monthly.* Many of the vertical orderings presented by *USN*'s competitors (such as *College Prowler's* rankings based on a "fair ratio of girls to guys," or *The Princeton Review's* "Reefer Madness" ranking [see Beam 2010]) seem largely unrelated to conventional depictions of organizational status. Within an implicit "ranking of rankers," *U.S. News & World Report* clearly occupies the top rung.

[7] Our focus on what *USN* refers to as *national* schools means that our panel excludes other classes of educational institutions covered in different rankings by *USN,* such as regional and baccalaureate schools. Unlike the narrow strategic purviews that often mark regional schools, national schools engage in relatively broad forms of peer monitoring and therefore present an especially interesting setting for studying inter-organizational peer effects.

(or ACT) range. An advantage of the SAT is that it serves as a representative of externally perceived quality, yet is not itself a status measure (cf. Avery et al. 2004). Using the inter-quartile range, and converting ACT scores to SAT scores via an official "Concordance" chart where necessary (Volkwein and Sweitzer 2006), we were able to calculate an average SAT score for nearly all schools in our panel each year.

Third, starting in 2005, *USN* included a list of the five *other* schools to which each school's students also applied with the greatest frequency. For instance, in 2009, New York University cited these five institutions as its most commonly overlapping schools: Boston University, Columbia University, Cornell University, Harvard University, and the University of Pennsylvania. That same year, Columbia University nominated these five institutions: Harvard University, MIT, Princeton University, Stanford University, and Yale University. These waves of inter-school network data, reported yearly in *USN*'s *Ultimate College Guide,* are valuable both for casting new light on a focal school's points of reference and for constructing a number of network-related covariates.[8]

U.S. News & World Report Rankings

When *USN* first published its rankings of U.S. colleges and universities in 1983, the hierarchical relationships it established were predicated solely upon elites' subjective appraisals. Unlike the elaborate yearly data collection that now marks *USN*'s approach, its original survey instrument simply requested "the opinions of university presidents on the five best schools in their

[8] While the *Best Colleges* issue presents a magazine-form overview of the annual rankings, as well as key statistics and application information for the top colleges and universities, the *Ultimate College Guide* is an exhaustive book-form aggregation of demographic, programmatic, student-body information for thousands of schools. These two annual publications jointly serve as consolidators of extensive information on the majority of places of higher learning in the United States. .

category. There was nothing scientific or subtle about the survey and most people shrugged it off. Donald Kennedy, president of then-first-ranked Stanford, said, 'It's a beauty contest, not a serious analysis of quality'" (Thompson 2000, pp. 1-2). Although several years later the magazine began distilling and synthesizing data on a variety of more objective inputs (a putatively scientific methodology for establishing ranks that it has continued up to the present), *USN* ranks are still widely conceptualized not as exact indicators of organizational worth but rather as a "gauge of status" (Nocera [2012, p. 2]; see also Bowman and Bastedo 2009; Sauder and Espeland 2006; Sauder et al. 2012).

Turning to the specifics of its current methodology, the magazine still depends disproportionately on the opinions of top administrators at other schools when calculating ranks, but now also incorporates outcomes for other key constituencies: students, faculty, and alumni. For example, *USN* employed the following seven-component weighting system when calculating its 2012 rankings of the colleges and universities in our panel. First, the strongest weight, 22.5%, was applied to the results of an "academic peer assessment" questionnaire asking "presidents, provosts, and deans of admission" from each school surveyed—as well as other related constituents, such as high school guidance counselors—to score all other schools with which they are familiar;[9] second, a 20% weight was attached to the student retention rate; and third, 20% was again applied to an aggregation of variables, such as class sizes and faculty salaries, gauging faculty resources. Components four through seven were weighted as follows: 15% for student selectivity measures (proxies for student quality, such as students' SAT scores), 10% for the

[9] Before the 2011 rankings, this was called the "peer score" and fell on a scale ranging from 1.0 (lowest perceived reputation) to 5.0 (highest perceived reputation). It was then renamed the "undergraduate reputation index," as it included survey respondents beyond just college deans and administrators. At that juncture, it was also put on a 100-point scale, though it remained a reflection of the external "expert" perception of each school. To make the peer score and reputation index commensurate, we divided the reputation index by 20, putting both figures on the same scale for inclusion in supplementary panel models we report in table 5.

school's financial resources, 7.5% for its graduation rate, and 5% for the giving levels of its alumni.

Taken together, these weighted values resulted in "overall scores" for each school, which *USN* then normalized to 100 for the top-ranked college and top-ranked university.[10] Through converting these cardinal scores to ordinal ranks, *USN* establishes a position for each school in each year. For example, in the 2012 ranking of liberal arts colleges, Williams, Amherst, and Swarthmore received overall scores of 100, 98, and 96 respectively, and accordingly occupied ranks 1, 2, and 3. In that same year, for universities, the overall scores of Harvard, Princeton, and Yale were 100, 100, and 98, and so they held ranks 1, 1, and 3. Importantly, ties in ranks (like the 2012 draw at the very top between Harvard and Princeton) are even more common beneath the upper echelons, and they occur by construction outside of the first tier. As an example, *USN*'s 2005 *Best Colleges* assigned ranks for colleges ranging from 1 to 105. Then, without explicitly specifying a second tier, the guide noted that alphabetically listed, third-tier colleges were tied in rank from 111 (there was a six-way tie at 105) to 161, while fourth-tier colleges (also listed alphabetically) were ranked from 163 to 215.[11] Given this feature of *USN*'s approach (see Sauder and Lancaster 2006 for law schools), whenever schools were listed alphabetically in a range of ranks outside the first tier, we assigned to those schools the average rank (rounded to the nearest integer) of the reported range. In addition, we used a corresponding dummy-variable approach for

[10] Although the weights assigned to each of seven component-categories have shifted over time, they have remained relatively constant. For comparison, the vector of percentages just summarized for 2012 were: 22.5, 20, 20, 15, 10, 7.5 and 5. For the 2005 rankings, using the same sequence, the weights were: 25, 20, 20, 15, 10, 5, and 5. Additionally, the weighting scheme varies depending on the Carnegie Classification of the schools: the national colleges and national universities in our panel have one weighting scheme, while for other categories, such as regional colleges and regional universities, the set of weights are slightly different. For example, "graduation rate performance" matters for the rankings of national schools, but not for their regional counterparts, for whom far fewer students graduate in a timely fashion, owing to a number of factors.

[11] *USN* implicitly established a second tier by listing only those schools ranked 1 to 50 on the first page of the rankings, while placing schools ranked 51 to 105 on the less-visible subsequent pages of the magazine (see Sauder and Lancaster [2006] for the implications of such placements among law schools).

these schools in our empirical models, whose implications for status change we discuss in the context of our models and results.

Measures of Peer Schools' Perceived Quality. We used data on lagged *USN* ranks to devise the first of two measures of the perceived quality of peer schools. Our choice to capture a focal school's peers in two distinct ways again reflects the multi-dimensional nature of competition in American higher education: a school's peers are those situated nearby in prior rankings, but also those holding comparable positions in the college-applicant market.

We refer to our first measure as *rankpeerSAT.* Weighting peers' influence as a function of proximity in prior rankings follows from two lines of scholarly work. The first is research on the process of commensuration (Espeland 1998; Espeland and Stevens 1998). Commensuration creates comparative relationships among previously disparate entities, driving the attention and focus of the compared entities directly to each other. Even if two schools differ widely on various qualitative dimensions (e.g., closely-ranked Bates and Oberlin have remarkably different institutional histories), if they are forced into similar positions in a single hierarchy, they will begin to closely monitor and affect each other (see also Espeland and Sauder 2007, pp. 16-22). Second, in a long tradition of sociological work on the architecture of competition (Baum and Mezias 1992; Hannan and Freeman 1977), inter-organizational rivalry is frequently viewed as acutely *local*. Reflecting limits on organizational attention as well as the highly stratified nature of most markets, many researchers have adopted a view in which organizations compete most strongly with their nearest rivals—a view that clearly characterizes competition among U.S. colleges and universities: while Bates and Oberlin are direct rivals, the University of Connecticut and Yale are not.

Consistent with these lines of work, we took the following five steps to construct *rankpeerSAT*.

First, we separated colleges and universities.[12] Second, we collected a set of absolute differences between the focal school's rank and the ranks of all other schools in its institutional pool. Third, we converted these absolute rank-differences to proximity scores by adding 1 and then inverting them. In other words, letting R_{it} denote the focal school's yearly rank and using $rankprox_{ijt}$ to represent the rank-based proximity of schools *i* and *j* in year *t*, $rankprox_{ijt} = 1/(|R_{it} - R_{jt}| + 1)$. With this nonlinear transformation, dyadic proximities drop rapidly from a maximum of one (when ranks are tied) toward zero (when ranks differ widely). This pattern concurs both with ecological conceptions of competition as highly localized (Carroll and Hannan 2000, pp. 274-78) and with network-theoretic portrayals of organizations anchoring on a small number of peers (Porac et al. 1995; White 2002). Fourth, we normalized the proximity scores for each school *i* so that they sum to 1.00 over other schools *j*: $\mathrm{w}_{ijt}^{(r)} = rankprox_{ijt} / \sum_j rankprox_{ijt}$. Fifth, we took the average SAT score for each school *j*, applied the normalized proximity scores as weights, and calculated a single, rank-based weighted-average peer SAT score for the focal school:

$$rankpeerSAT_{it} = \sum_j \mathrm{w}_{ijt}^{(r)} \, AvgSAT_{jt} \qquad (1)$$

As *rankpeerSAT* for a given school rises, other schools nearest in rank to that school show an improvement in the test scores of their students.

Using a parallel approach, we constructed a second measure of peer schools' perceived quality, *citepeerSAT*, derived from proximities in the college-applicant market. Taking account of this

[12] Separating by institutional type is an important first step in the construction of a sharply localized measure: colleges compete for ranks with other colleges, and universities separately compete with other universities. Conversely, when devising a measure of informal status in the college-applicant market using Bonacich's (1987) method, we include all schools in one pool, because there are tendencies for both colleges and universities to "cross-list" each other as overlap schools, with no specific restrictions on which schools a focal school specifies as its overlaps.

second form of inter-school proximity is important because schools face different peers in different arenas. Schools are peers not only when they hold neighboring positions in lagged *USN* rankings and thus overlap in prior "outputs"; consistent with work on structural equivalence (Burt 1987; White, Boorman, and Breiger 1976), schools are also peers, although in a distinct arena, when they occupy comparable positions in the college-applicant market and therefore overlap in "inputs."[13] For instance, although Duke and UNC-Chapel Hill held discernibly different ranks in 2006 (ranks 5 and 26 respectively), they were still near-peers in the market for incoming students. Duke and UNC-Chapel Hill jointly cited UVA as an overlap school, and they were jointly cited by Furman University, Morehouse College, UVA, and Wake Forest.[14]

To construct *citepeerSAT* from these relational data, our first step in devising a strongly localized peer measure was again to collect only those schools of the *same* institutional type (college or university) as the focal school. Next, we computed *two* Euclidean distances in citation patterns between the chosen school and its counterparts. We calculated these distances from yearly-varying matrices of inter-school citations $\mathbf{C}_t$, where $\mathbf{C}_t = \left[c_{ijt} \right]$, $c_{iit} = 0$, and $c_{ijt} = 1$ if school *j* cited school *i* as an overlap in year *t*. Consequently, to the extent that *i* and *j* have similar row vectors in $\mathbf{C}_t$, the same schools nominate them as overlaps, and to the degree that they have

[13] We use the term "output" from the perspective of the status-attentive *school* seeking to generate for itself best possible rank. Conversely, from the perspective of other *rankers* competing with *USN*, a true "output" is different. To take an example from *Forbes* (Vedder 2010, p. 2): "The FORBES scorecard of higher education ... is very different from what you see in other publications. We measure outputs (like career success later in life) rather than inputs (like SAT scores), and we put a lot of emphasis on the economics of the transaction. Our advice to high school seniors: Shop wisely. Outside of a house, this is probably the biggest investment you will make."

[14] Separate from citation-based and rank-based peers, the peers that contribute to a focal school's "academic peer assessment" score represent a third type of peer. Deans and administrators are sent USN's annual survey and asked to assess those schools about which they are familiar, and to indicate that they "don't know" when applicable. Thus, it is a self-selecting group of peers (not reported by USN) who feel sufficiently informed to comment on the academic reputation of a focal school. These survey respondents thus create a distinct peer group, yet one that almost certainly overlaps strongly with the two varieties on which we have focused.

similar column vectors, they nominate the same schools as overlaps. Letting $citedist_{ijt}$ denote the distance between *i's* and *j's* rows *plus* the distance between *i's* and *j's* columns, we then computed the citation-based proximity of *i* and *j* as $citeprox_{ijt} = 1/(citedist_{ijt} + 1)$. Using a reciprocal transformation from distances to proximities again reflects the premise that, rather than orienting to a large swath of rivals, a chosen school is instead subject to a relatively small radius of peer influence. After normalizing $citeprox_{ijt}$ for each school *i*, so that $\mathrm{w}_{ijt}^{(c)} = citeprox_{ijt} / \sum_j citeprox_{ijt}$, and gathering average SAT scores for *j*, our second peer school measure may be expressed as:

$$citepeerSAT_{it} = \sum_j \mathrm{w}_{ijt}^{(c)} AvgSAT_{jt} \qquad (2)$$

As *citepeerSAT* for a chosen school rises, other schools similarly situated in the college-applicant market boost their take of high-scoring students.

Estimation and Conditioning Variables

To assess empirically the two competing views of peers' perceived quality and status change we have summarized, we estimate two-way fixed effects panel models of the form:

$$\Delta R_{i,t+1} = \rho R_{it} + \mathbf{X}_{it}\beta + \theta rankpeerSAT_{it} + \gamma citepeerSAT_{it} + \sigma_i + \tau_{t+1} + e_{i,t+1} \qquad (3)$$

where $\Delta R_{i,t+1}$ denotes school *i's* rank in year *t+1* minus its rank in year *t*. Our unit of analysis is therefore the individual college or university whose year-to-year change in *USN* rank is modeled from 2006 through 2012. We focus on a focal school's absolute growth (or decline) in rank for two main reasons. The first is our overarching interest in within-school variance in status *change* (as opposed to between-school variance in the *level*), and the second reflects the substantive importance schools attach to their annual movements in position. Schools' top administrators and alumni fret over downturns in rank and they celebrate ascent; we aim to identify the peer-based antecedents of such positional shifts.

In addition to conditioning on prior rank, we include seven adjustments in the matrix $\mathbf{X}_{it}$ whose coefficients are in β. Three of these adjustments are straightforward and may be briefly described together with their expected effects, while the other four call for additional explanation. Table 2 presents correlations and descriptive statistics for all variables used in our analyses.

[Table 2 about here]

First, we include an indicator variable *alpha*, which is set to 1 if the focal school is *not* included in *USN*'s top tier. Such placement means a school is listed alphabetically with a band of the other non-top tier schools, rendering their ranks and overall scores indistinguishable, while their better-positioned counterparts enjoy more widely spaced overall scores. We expect this covariate, net of prior rank R_{it}, to affect future rank change discernibly. In particular, once a school gains first-tier standing (i.e., *alpha* turns from 1 to 0), new visibility and increasingly favorable expectations may trigger continued improvements in standing (Merton 1968).

Second, we hold constant the *AvgSAT* of the focal school (measured as the mean of its 25th and 75th percentile SAT scores), which we expect to exert a favorable effect on rank mobility, net of other covariates. Holding a focal school's average SAT constant is mandatory in light of our primary interest in the effect of *peer* schools' average SAT.[15]

Third, we adjust for *tuition* charged in the prior academic year. We do so because on one hand, tuition is a signal of quality: schools can (within limits) convey higher quality by charging more (Shapiro 1983). On the other hand, schools are essentially incentivized by *USN* to raise—or at least maintain—tuition levels, as they are rewarded in the rankings for certain types of spending. This includes paying for new faculty and additional classes in order to keep class size small (Nocera 2012). Since schools do not reveal the amount of annual spending on these changes, tuition levels provide a particularly valuable adjustment.

Our fourth through seventh control variables are relational covariates requiring greater explication. The first of these is a measure of the level of differentiation clustered around a focal school's rank. Recall that *USN* frequently reports schools as tied (and thus crowded) in rank. To adjust for the potential competitive consequences of this feature of *USN*'s design, we constructed the variable *weighted rank difference*. This variable addresses this question: on average, how far away, in rank, are a reference school's *nearest* neighbors? To calculate *weighted rank difference*, we took two steps: collect the same row-stochastic peer weights $\mathrm{w}_{ijt}^{(r)}$ used for *rankpeerSAT* and then apply these to absolute differences in rank between schools *i* and *j*. This covariate is thus given by $\sum_j \mathrm{w}_{ijt}^{(r)} \mid R_{it} - R_{jt} \mid$. We expect that as the differentiation (crowding) around a focal school's current rank increases, its future rank will then improve (decline).

Another relational covariate is a measure of network-based status, created using Bonacich's (1987) method on yearly matrices of citations. Recall that c_{ijt} in $\mathbf{C}_\mathrm{t}$ equals 1 if *j* cites *i* as a

[15] In computing average SAT for each school, we found that a handful of schools only reported a single SAT score, instead of an inter-quartile range. In these instances, the single score was used as average SAT. Checking schools that switched from providing a range to a single number—or vice versa—over the course of our panel revealed that the single numbers are, in fact, averages.

school to which its own applicants also apply, 0 otherwise. These relational data allow us to detect a dimension of status that is analytically and substantively distinct from *USN* rank. While we view rankings as public, "official" indicators of status constructed by third party mediators (Sauder and Fine 2008), school-to-school citation patterns offer insight into the latent perceptions of external constituents deciding where to apply. These constituents are not restricted to students; they also include parents, guidance counselors, and alumni. To the extent that a focal school receives citations from other schools which are *themselves* widely cited, that school occupies a prestigious location in the college-applicant market. Such a school is sought out by students (and those influencing them) who seek admission at the most desirable places.[16]

Using citations in $\mathbf{C}_t$, the network-based status of school *i* at *t* is given by:

$$S_{it}\left(\alpha,\beta\right)=\sum_{j}\left(\alpha+\beta S_{jt}\right)c_{ijt} \tag{4}$$

where α is a scaling constant and β is a network-weighting parameter set to ¾ of the reciprocal of the largest normed eigenvalue of $\mathbf{C}_t$ (Podolny 1993, 2005).[17] Our expectation is that as a school increases in network-based status, thus improving its informal standing in the applicant market, an

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[16] While schools do not reveal to *USN* whether their students were accepted or rejected from the overlap schools they list, the network created by these citations is a particularly valuable source from which to construct a measure of status. Consider two simple comparisons. First, compare a school receiving many citations with a school receiving none. Clearly, the former is more desirable and, therefore, perceived to be better than the latter. Second, take that school which receives many citations and compare it with another school also that receives a similarly large number. These two schools can differ on an important dimension: the schools from which their citations originate. Imagine that the first gets all its citations from un-cited schools, while the second gets its citations from widely cited schools. In this second pair-wise comparison, the latter school is now perceived as the better of the two. Following the construction of the Bonacich (1987) measure of status, our network-based status measure first compares the count, and then the source, of citations.

[17] Using matrix terms, we can re-express equation (4) as $\mathbf{S}_t\left(\alpha,\beta\right)=\alpha\sum_{k=0}^{\infty}\beta^k\mathbf{C}_t^{k+1}\mathbf{1}$ where $\mathbf{1}$ is a column vector of ones. To give a sense of how particular schools rank in terms of network-based status, these were the top five highest-scoring schools on the measure in 2005: Harvard, Yale, UPenn, Cornell, and Stanford. For comparison, the top five in 2011 were: Harvard, Stanford, Yale, Princeton, and Cornell.

ascent in *USN* rank will follow.

Related to this measure, we enter two further adjustments. One is the average network-based status of those schools *cited* by a focal school (*cited alters' network status*). We include this to adjust for the rank-related consequences of strategic steps a school may take when listing its overlaps. Although *USN* expects each school to indicate its overlaps truthfully, it is possible that schools are consciously strategic (or perhaps unconsciously biased) as they make choices about which institutions to cite. As an example, a status-anxious school may "over-list" Ivy League schools in an attempt to appear to be on par with those schools. The consequences of such behavior could be favorable or unfavorable for focal school. On one hand, if others take self-reports of overlap schools as a credible signal of quality, rank might improve. On the other hand, those "aspirational" peer schools, when submitting their own appraisals to *USN* of the focal school, may punish over-reaching. Such reproach would play an active role in weakening the status-anxious school's position in the tournament.

Second, whenever a school chooses *not* to cite any schools as an overlap in a given year, it is assigned a 0 on *cited alters' network status* as well as a 1 on an associated dummy variable we term *zero out-degree*. This additional covariate is important not only for adjusting for cases in which we replaced missing values on *cited alters' network status* with zeroes; entering *zero out-degree* as a covariate is also important substantively. In particular, although this phenomenon is increasingly rare over the course of our panel, some schools appear to be unwilling to "play the rankings game" (Farrell and Van Der Werf 2007; Machung 1998) and refuse to submit requested information to *USN* in certain years. Entering this indicator variable into our models enables us to examine the possibility that schools vary over time in their overall commitment to *USN* and, as a result, may shift in rank.

Our final terms in equation (3), in addition to our two peer school SAT variables, are fixed effects for schools and for years. These are represented by σ_i and τ_{t+1}, respectively. We enter fixed effects for schools to adjust for time-constant tendencies to rank favorably. In our setting, including separate dummy variables for all schools is important in light of well-known variations in general perceptions of the institutions covered by *USN*. Other important factors for which the fixed effects adjust include founding year, institutional type (for instance, public versus private, college versus university) and geographical location.

We include year fixed effects because the "meaning" of a given rank changes annually, as the result of the time-changing count of schools covered by *USN*. For example, in 2006, *USN* included 215 colleges on its list and 248 universities. By 2011, these populations had broadened to rank 250 and 259, respectively. Our inclusion of year indicators sweeps out the consequences of a yearly-varying average rank, while also ensuring that all year-to-year fluctuations in the means of other covariates are similarly held constant.

Results

We present estimates for two-way fixed effects models predicting future change in *USN* rank in table 3. We begin in model 1 with a simple set of actor-level covariates before proceeding to models that adjust for additional sources of variation. In this baseline model, in addition to fixed effects for schools and for years, we enter only lagged rank, our indicator for alphabetical listing (*alpha)*, average SAT, and tuition. The school fixed effects (not shown but available by request) reveal sharp between-school differences in propensities to rank favorably net of other covariates, reflecting the merits of the within-school estimator. Year indicators absorb jumps in the count of schools annually appraised by *USN*.

[Table 3 about here]

Coefficients on lagged rank and *alpha* show how predicted changes in rank vary with prior standing. Recall that schools wish to post a "negative" annual rank change, meaning that negative (positive) coefficients reflect desirable (undesirable) within-school effects of increases in covariate values. Expected future rank change is (unsurprisingly) more favorable for worse ranked schools, and the effect of the *alpha* dummy isolates the consequences of traversing a visible status-related threshold imposed by *USN*. Adjusting for other factors, a school's rank improves (worsens) by nearly three places once it enters (falls from) the first-tier. In addition, the negative coefficient on average SAT indicates that, net of lagged rank, as a school enrolls higher-scoring students its position subsequently improves. Using the estimate from model 1, a 150-point increase in average SAT brings about a yearly ascent of nearly four ranks (-.026 x 150 = -3.9).[18] Moreover, as a school charges higher tuition, its rank improves discernibly the following year.

Shifting to model 2, we see first that *weighted rank difference* exerts a significant favorable effect on future rank change (-2.76 *t*-test). As expected, the less a focal school is crowded by its nearest neighbors, the better its subsequent standing. Conditioning on this variable is particularly important because it will aid us in distinguishing peers' perceived quality from the sheer proximity of these peers due to ties in lagged rankings. As this mean proximity increases, the focal school faces a greater risk of rank decline.

[18] We note also that the significance (statistically and substantively) of the focal school's average SAT underscores this measure's importance as an antecedent of future rank change precisely because (as noted previously) SAT is an input to the rank itself: SAT is part of the 15% weight accorded to the student selectivity component of the annual ranking. Consequently, in a within-school model predicting rank change as a function of prior rank, the interpretation of the SAT effect is as follows: comparing the same school at two time-points over its history—where, at both junctures, its rank is *identical*—the more its current SAT contributes favorably to its current rank, the better its future rank.

In addition, although our citation network-based measures fall short of statistical significance, the direction of the effect of the network status measure concurs with our prior expectations. While our focus is primarily on year-to-year changes in "official" status as indicated by the *USN* rank, it is also important to investigate the potential consequences of "informal status" in the college-applicant market. As noted earlier, this is because there may be time-varying shifts on how the focal school is perceived that are *not* captured by lagged *USN* rank. Network-based status is intended to adjust for these otherwise unobserved movements in perceptions.

In model 2, we also enter *cited alters' network status* to adjust for the potential consequences of "reaching up." Conditioning on this measure helps to alleviate the concern that schools' locations in the applicant market (and thus the composition of their peer group) are partially affected by strategic self-presentation: as a school forecasts a better future rank, or as it takes extraordinary steps to ascend in rank, it may simultaneously offer biased self-reports of its overlaps in the applicant market. By entering this covariate, we can examine the effects of peer schools' average SAT net of the effects of self-presentational citations.[19]

Models 3 through 5 report estimates for both peer school measures. Although the correlation between *rankpeerSAT* and *citepeerSAT* shown in table 2 is only .25 (a reflection of sharp compositional differences between rank-based and citation-based peer-groups), we enter these separately before including them jointly to ensure that colinearity does not drive the effects we observe. In model 3, *rankpeerSAT* is significantly positive: as rank-based peers improve in perceived quality, a focal school's rank *worsens* in the next year. Conversely, in model 4, *citepeerSAT* is significantly negative: as peers in the applicant market increase in perceived

[19] To the extent that schools do engage in such behavior, plausibility constraints are of course quite strong: a relatively unknown institution cannot credibly name Harvard, Yale, and Princeton as all existing among the top schools to which its own students also apply (though surely there could be some students who applied to these places). The potential concern is citation behavior at the margin. When administrators consider data showing that their students apply to Harvard and, say, Brown, these administrators may behave strategically insofar as they cite the former even though slightly more of their students in fact applied to the latter.

quality, the focal school's rank subsequently *improves*.

This pattern of effects stays largely unchanged when both peer measures enter jointly. Each uniquely affects future rank change, and they do so net of actor-level controls. More specifically, the ecological effect of *rankpeerSAT* holds net of the focal school's contemporaneous rank and average SAT level. This means that the competitive dynamics observed among schools cannot be attributed to a drop in absolute SAT on the part of the focal school. Nor can the contagion effect captured by *citepeerSAT* be traceable to a rise in the focal school's SAT, which might in turn alter the makeup of that school's peer set. Consistent with the theoretical direction suggested by Sauder, Lynn, and Podolny (2012), we instead see evidence of peers affecting status change net of ego-specific adjustments.

More generally, the countervailing effects of *rankpeerSAT* and *citepeerSAT* in model 5 show that the competing hypotheses laid out previously appear to be reconcilable. In our empirical setting, this is possible if we address the "boundary specification problem" (Laumann, Marsden, and Prensky 1983, esp. pp. 18-19, 30-33) from a *dual* perspective.[20] One of the most important (and frequently under-examined) questions in any network-analytic approach is: what constitutes a relevant network tie? In our context, competitive ties between schools emerge meaningfully from structural similarity in the college-applicant market, but also from proximities in prior ranks. By capturing a focal school's peers in two distinct ways—one following a long tradition of sociometric research (Burt 1987; White et al. 1976), and a second consonant with recent research on commensuration (Espeland and Stevens 1998; Sauder and Espeland 2009)—a more complete portrayal of peer influence comes into view. There is initial evidence of contagion among

[20] We sketch key features of two different kinds of contests for status in our concluding section. We do so to present counter-factual scenarios that offer points of departure for future work on peer effects in status tournaments. Our emphasis there is on (1) *middle-status* tournaments for ranks—for example, among regionally focused schools—as well as (2) contests for ranks with *multiple rankers*—for instance, among business schools.

citation-based peers, yet there is also preliminary evidence of ecological competition among rank-based peers.

Adjustments to standard errors. In models 6a-6c, we assess the robustness of these main effects by clustering the standard errors on three dimensions. We do so to guard against the possibility that our results are affected by localized unobserved processes (spatial, institutional, or inter-organizational) that might jointly affect peers' perceived quality and a focal school's rank mobility.

The first dimension is regional. In model 6a, where standard errors are clustered at the state level (including Washington, D.C.), we find that our two peer measures remain discernibly significant (*t*-tests of 2.48 and -3.76 respectively). Second, in model 6b, we cluster by athletic conference,[21] which also yields significance tests well above the standard level of confidence. Third, in model 6c, we cluster standard errors by the focal school's time-invariant location in the inter-school citation network. Unlike state and athletic conference, this dimension requires explanation.

We began by assembling a single matrix $\mathbf{C}_T$ of inter-school citations that aggregates each yearly matrix $\mathbf{C}_t$ from 2005 through 2011.[22] In this overall matrix, cell c_{ijT} takes a maximum value of 7 if, in all seven years, school *j* cited school *i* as the school to which its students also applied. Next, we constructed a corresponding matrix $\mathbf{D}_T$, recording pairwise sums of Euclidean

[21] A total of 120 conferences are represented in our panel. They range from well-known associations—the ACC, Big East, and Big Ten—to lesser-known leagues, such as the Liberty League and the Empire 8.
[22] Although our models predict rank changes into 2012, the most recent yearly matrix $\mathbf{C}_t$ contributing to $\mathbf{C}_T$ is for 2011. We used the 2005 to 2011 range because these are the years during which we measure (lagged) peers' average SAT levels using time-changing peer weights.

distances between the rows and the columns of $\mathbf{C}_T$. We then submitted the overall distance matrix $\mathbf{D}_T$ to a *k*-means clustering algorithm (Everitt and Hothorn 2006; Hartigan and Wong 1979; MacQueen 1967), which indicated that a solution of five clusters was most appropriate.[23]

These five clusters are represented in a set of sociograms, together with their respective descriptive statistics, in figures 3 through 7. We return to these figures in subsequent analyses of interaction effects by cluster. For now, we emphasize that computing standard errors corrected at the level of the network cluster in model 6c yields estimates of peer effects that fully maintain their significance. More generally, the robustness of the effects across these different standard-error adjustments allow us to conclude with greater confidence that lagged shifts in peers' perceived quality—rather than localized processes that elude observation—affect changes in rank.

Additional Robustness Checks. Moving to table 4, our objectives are twofold: to further assess the robustness of the main peer effects in models that address alternative explanations raised by the nature of the peer weights, and to clarify the circumstances in which the peer effects are strongest.

[Table 4 about here]

Perhaps the most significant challenge facing a dynamic model of peer influence is to ensure that the observed coefficients result not from endogenous inter-temporal fluctuations in the peer

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[23] According to Macqueen (1967, p. 283), who was among the very first to refer to this method, *k*-means clustering begins by seeding each of *k* groups around a random focal point. Each new point is then allocated to a chosen group according to a simple decision rule: the new point is closer to the mean of the chosen group than to that of the other *k*-1 group means. Once a new point is added, the mean of group *k* is updated accordingly, and the process continues until all points are allocated to one of the $k = 1, 2, \ldots, K$ clusters. We selected the five-cluster solution by graphing the sum of squares for the entire (clustered) network across 2 through 15 clusters, inclusive. After initially dropping sharply, the sum of squares did not decrease substantially beyond the five-cluster partitioning of the network.

weights, but rather from true dynamics in the *object* being weighted. This challenge directly concerns the effect of *citepeerSAT*. Although time-changing peer weights offer the clear advantage of precisely capturing a focal school's closest competitors in each year, an equally apparent issue arises from the use of time-varying weights. The concern is that locations in the inter-school citation network may vary endogenously over time with unobserved processes that both push a focal school into closer contact with better peers and also enhance that school's future rank.

Although this endogeneity story does not present a concern for our interpretation of the ecological effect of *rankpeerSAT*—rank-based peers *unfavorably* affect subsequent changes in position—rank-based peer weights do raise an important question: could the effect of *rankpeerSAT* result from a nonlinear effect of lagged rank? We believe it is vital to examine this possibility because the peer weights are, by construction, a function of inter-school differences in prior rank and due to the relatively high correlation between lagged rank and *rankpeerSAT* shown in table 2, which is -.84. In model 7, we fit the effect of prior rank nonlinearly, with lagged rank squared and cubed entering along with the linear term. In this model, coefficients on these higher-order terms are insignificant, and we find that the coefficient on *rankpeerSAT* stays strongly significant (4.01 *t*-test). We therefore conclude with added confidence that rank-based peers' student-body average SAT scores, rather than a non-linearity in prior rank, affect a focal school's prospects for positional change.

Turning to the robustness of the effect of *citepeerSAT*, our approach in model 8 involves several steps. We begin with a more conservative measure of *citepeerSAT*. Recall that we are interested only in accounting for *within-school* variation in yearly changes in *USN* ranks, and that all models therefore enter fixed effects for schools. While this necessarily keeps us from a broader analysis of between-school variations, our restrictive focus on within-school effects offers a valuable analytic opportunity. More concretely, by including a full set of dummy variables for schools, and then by computing peer-weights from time-*constant* distances between schools (i.e., from peer relationships aggregated across our empirical time frame), we can isolate the effects of changes in the SAT scores of a focal school's citation-based peers. And we can do so net of unobserved, time-fixed tendencies to "locate" near these peers in the market for students.

Stated more formally, this alternative measure of *citepeerSAT* involves one simple change from equation (2): instead of yearly-updated peer weights $\mathrm{w}_{ijt}^{(c)}$, we use weights from time-invariant Euclidean distances, which we denote by $\mathrm{w}_{ijT}^{(c)}$. To calculate these weights, we began with the same aggregate matrix of inter-school citations $\mathbf{C}_T$ (figure 2 presents a sociogram based on this matrix) from which we extracted the five time-invariant clusters of schools discussed previously. We then took exactly the same steps used to compute *citepeerSAT* in equation (2): calculate distances between the rows and columns of $\mathbf{C}_T$; convert distances to proximities using a reciprocal transformation; normalize the proximities so that they sum to unity for each school at each time point; and apply these weights $\mathrm{w}_{ijT}^{(c)}$ to peers' annually-changing average SAT scores. Importantly, a given school's distance from a particular peer is now *fixed* over the course of the panel. Therefore, the effect of this distance is swept out by the fixed effect for that school.

[Figure 2 about here]

Two factors can then change yearly in this alternative measurement of *citepeerSAT*, both of which we assume to be exogenous. First, although the underlying distances are fixed, because $\mathrm{w}_{ijT}^{(c)}$ are row-stochastic, these weights can fluctuate in response to yearly entries and exits of particular peers from the panel. Second, lagged peer-school SAT scores change year-over-year, and it is the effects of these changes in the *object* being weighted that we wish to estimate.[24]

Using this alternative version of *citepeerSAT* as an instrumental variable in model 8, we see continued evidence of inter-school contagion. This time-constant alternative is correlated with the version of the measure using time-varying peer weights, but not driven by the focal school's recent movements through the inter-school citation network. With peer weights derived from fixed distances in the citation network, the effect of *citepeerSAT* is robustly significant. This effect cannot be traceable to an unobserved endogenous process by which a focal school draws closer to better peers. Aside from panel attrition and expansion, the effect instead reflects changes in the SAT scores of the *same* set of peers.

Contingent Peer Effects. Having assessed the robustness of these effects from multiple angles, the remaining models in table 4 address a key question: in what network-related circumstances are the observed peer effects most strongly concentrated? We focus on the underlying bases of proximity for both peer measures.

In model 9, we interact *rankpeerSAT* with lagged rank and find that while peers' encroachments exert no impact on well-ranked schools, the ecological effect is acute for the worst ranked institutions. Correspondingly, in model 10—which interacts *rankpeerSAT* with *weighted rank difference*—the same picture surfaces, although more precisely. The pattern in model 10, in which the effect of *rankpeerSAT* approaches zero as a school's niche is increasingly differentiated, reveals that it is schools nested together with adjacent neighbors that must deal with the rank-impairing effects of peers' advances. In contrast, the null hypothesis of no ecological effect

[24] We also note that this version of the measure conservatively works against the possibility of observing an effect of citation-based peers: because the peer weights come from fixed distances an aggregated matrix, the set of schools identified as most proximate to the focal school—especially in the middle years the panel—include other schools that are no longer, and not yet, actually closest to the focal school. Our expectation is that the lagged SAT scores of these time-constant peers should therefore be slightly less influential for the reference school.

cannot be rejected for their higher-ranked, less crowded counterparts. These schools, enjoying their ascendant place in the *USN* hierarchy, are buffered from rank-based rivals.

More generally, models 9 and 10 jointly suggest that the ecological struggle forcing one school down while peers ascend is caused by the design of the tournament itself. How intentionally *USN* engineers this is not for us to say. What is clear is *USN's* interest in designing a tournament for ranks that encourages some volatility every year—they must sell magazines that publish new rankings (Gottlieb 1999)—but which can still pass a "sniff test" (Machung [1998] refers to this idea as "credible instability"). That is, the rankings must align closely enough to the general population's perceptions of the collegiate status hierarchy in order to remain at least ostensibly credible. For example, if Bowdoin or Columbia were to fluctuate sharply from one year to the next, this would lead readers to question the validity of the rankings (more than they already do). Changes for schools at the top must be relatively modest and infrequent for sake of legitimacy (Dichev 2001). Conversely, churn among crowded schools at the bottom can be comparatively dramatic, and at no significant cost to the tournament's architect. While not as marginalized as the so-called "colleges of the forgotten Americans" (Dunham 1969; Lovett 2005), these institutions are not nearly as well known (and presumably not nearly as influential with *USN*) as their elite counterparts. Thus, it appears that *USN* constructs a contest that fosters yearly variability, but which also shields the higher-ranked schools enough to ensure a level of stability that sells magazines and keeps administrators in the game. The net effect is for schools at the lower end to experience heavy competition for their ranks, while those at the top can breathe more easily.

Unlike the multiplicative effects of models 9 and 10, which point directly to the exogenous role of *USN*, interactions presented in model 11 reveal that endogenous population structuring (Podolny et al. 1996, p. 66) shapes peer influence. Consider again the cluster-specific sociograms in figures 3 through 7. Some schools, such as Duke and Michigan in cluster 2, contend head-to-head with the most elite national institutions. In contrast, others, like Middlebury in cluster 3, compete less intensely with more regionally focused rivals.

In model 11, we interact *citepeerSAT* with cluster indicators. The main effects of cluster membership are spanned by the school fixed effects. The contingent effects reveal significant cross-cluster differences in peer-school influence. We interact *citepeerSAT* with all five binary switches to ease comparison of the relative effect magnitudes. The effect of *citepeerSAT* is particularly strong in cluster 2, which contains many of the elite colleges and universities, while it is noticeably weaker in clusters 3 and 5. The descriptive statistics for each cluster offer plausible reasons for the relative strength of the contagion effect in cluster 2.

[Figures 3 through 7 about here]

Considering the discernibly higher measures of status and density for cluster 2, compared to the other clusters, we interpret the interaction effects in model 11 as suggestive evidence of two factors—status and density—moderating the main effect of *citepeerSAT*. First, consistent with research on diffusion, elite schools (concentrated in cluster 2) may also be the most "infectious" peers in Strang and Tuma's (1993) sense. For a school that competes with the most visible and well-regarded institutions, its response to their perceived quality is most pronounced. Second, consistent with work on closure and embedding (Burt 2005; Coleman 1988; Granovetter 1985), it is likely that proximity to peer schools which are *themselves* strongly intertwined (another salient feature of cluster 2) also amplifies peer influence. Vying for students with tightly-knit others should have the effect of increasing inter-organizational monitoring. We speculate that in the densest cluster of the network, stories of peers' outcomes arrive faster and from multiple sources (Centola and Macy 2007), inciting a particularly strong response in the focal school.

[Table 5 about here]

Rank-input models. Three final models presented in table 5 allow us to be more precise about the particular dimensions along which schools respond to advances of their peers in the college-applicant market. Earlier, we drew a distinction between cosmetic and material responses to peers' encroachments. In keeping with that contrast, here we examine the effect of *citepeerSAT* on year-over-year changes in three inputs to the *USN* rank: the peer assessment score, the alumni giving rate, and the focal school's average SAT. Each of these inputs, as noted in the preceding summary of our data, is an important factor in the overall score and, thus, the *USN* rank. We analyze these here because they map (albeit roughly) to qualitatively different places on a continuum ranging from cosmetic to material reactions. Efforts at improving the peer assessment score strike us as closest to a purely cosmetic reaction, netting high-scoring students is the best available indicator of material change,[25] and we view the alumni giving rate as residing between the ideal-typical poles.

Consider first the peer assessment score. Although better peer appraisals can certainly be earned, the prevailing view is that administrators labor deftly to manipulate this (fully subjective) dimension of the rank. According to de Vise (2010, p. B01), this assessment is the focal point of "one of higher education's little-known spring rituals" during which administrators "lobby... each other for better 'peer assessments' in pursuit of a higher spot in the coveted rankings compiled by

[25] Other outcomes that would also be interesting to examine in this context, such as the faculty resources rank, are missing data in a large number of cases.

U.S. News & World Report... Every year, hundreds of college presidents seek to improve their scores by sending counterparts at other schools glossy mailings, interactive CDs and books that celebrate their institutional feats." Such behavior is often deemed "unseemly," leading William Durden, President of Dickinson College, to describe it as a "PR gimmick."

In model 1 of table 5, we assess the possibility of peers pushing up a focal school's future rank by prompting largely cosmetic responses. We present within-school two-stage least squares estimates predicting annual growth in the peer assessment score. Aside from the new outcome variable, this model is identical to model 8 in table 4, but with one exception: we also include the peer assessment score lagged. To address the possibility of selection in these models as well, we again instrument for *citepeerSAT* using the version of the measure derived from time-constant network distances.

Coefficients reveal an intriguing picture that also differs remarkably from the pattern one would anticipate if cosmetic responses were at work. Within-school variation in the peer assessment score appears to be mainly driven not by the focal school but rather by raters' *own* sense of the competitive threat that school presents. Adjusting for its fixed effect, a given school garners the *least* generous appraisals when it ranks better, when it charges more, and as its rank-based peers fall behind. Under these circumstances, the temptation facing those rating that school—to "deliberately downgrade their competitors to try to drive down their showing" (Finder 2007)—may seem especially alluring. Correspondingly, a school also receives a lower rating insofar as (holding fixed its own network-status) it cites other schools whose network status is high. Raters appear to retaliate against "reaching up" behavior geared toward basking in others' reflective glory (Cialdini et al. 1976; Zuckerman and Jost 2001).[26]

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[26] This interpretation turns on the (very plausible) assumption that administrators are aware of the relational data recorded by *USN*.

The *negative* effect of *citepeerSAT* differs from this general pattern. We view this effect as reflecting "fair play" relative comparisons, not status-anxious efforts to "drive down" the rated school: adjusting for that school's average SAT, *worse* peer assessments occur insofar as proximate schools in the college-applicant market do better on this dimension. Most importantly, the negative effect of *citepeerSAT* in model 1 runs against an account in which peers' advances elicit favorable rank mobility mainly by encouraging "successful" lobbying for better subjective appraisals. Instead, the peer assessment drops as a school's counterparts pull in high-scoring students. While improving the peer score through influence activities is certainly not the only way to superficially raise the *USN* rank, the negative effect of *citepeerSAT* in model 1 suggests that cosmetic responses are *not* disproportionately responsible for the favorable changes in rank we observe.

We turn in model 2 to an analogous model predicting growth in the alumni giving rate. We explore this outcome because it resides close to a midpoint between material and cosmetic change: progress along this dimension may reflect good faith efforts to bring in new resources, but may in a few cases result from manipulation.[27] In model 2, we see that although alumni are more active as their alma mater's own SAT scores rise and when its tuition is lower (a substitution effect), the positive effect of *citepeerSAT* is insignificant.

Conversely, in model 3, which predicts future growth in the focal school's average SAT score, the positive effect of *citepeerSAT* is strongly significant (4.20 *z*-test). This effect holds net of lagged average SAT and lagged rank. Although we view yearly improvement in own SAT as the

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However, to the extent that mean *cited alters' network status* is also correlated with the practice of actively lobbying for a higher peer score—a practice many on the receiving end find distasteful—negative reciprocity could also explain the effect.

[27] As Finder (2007) notes: "U.S. News reports the proportion of a university's alumni who contribute money each year, as a way of measuring consumer satisfaction. Michael Beseda, Vice President for enrollment at St. Mary's College of California, said he knew someone whose college sent him a $5 bill, asking him simply to send it back so it would count as a donation. Several colleges have admitted taking a single donation and spreading it over two, three or five years, to raise their annual numbers."

best available outcome for assessing whether schools meaningfully react to peers' advances, we cannot rule out the possibility that this partially results from targeted schools' manipulations of their SAT data.[28] What we can assert is that the effect is substantively significant: a 100-point improvement in peer schools' SAT scores results in a nearly 33-point subsequent increase at the focal school. We also contend that one of the main ways in which peers favorably shape a focal school's growth in standing is by triggering efforts at that school to bring in higher-scoring students. Unlike the negative effect of *citepeerSAT* in model 1 predicting peer score growth, and in contrast to the insignificant effect in model 2 predicting change in alumni engagement levels, the effect in model 3 substantively meaningful and consistent with inter-school contagion.

Conclusion

In the classical status literature, Merton (1968) used two main images to capture important facets of status: a chair and a mountain. In drawing the analogy between a status position and a chair, Merton's argument was fundamentally ecological: one scientist gets anointed by the French Academy, while another is consequentially forced out, into the "41st chair." Yet, in contrast, when likening a scientist's status mobility to mountain climbing, Merton stressed the potent effects of peer pressure: "social pressures do not often permit those who have climbed the rugged mountains of scientific achievement to remain content... More and more is expected of them, and this creates its own measure of motivation and stress" (p. 57). Similarly, in taking an alter-centric view of

[28] Three main strategies, aside from lying, have been pursued when schools wish to "game" the SAT data sent to *USN*. (1) Pay students to re-take the test—a relatively "transparent ploy to boost the average scores [a school] can report" (Slotnil 2012). (2) Make the SAT optional. As Ehrenberg (2001, p. 13) notes: "One does not have to be a space scientist to realize that if the test is optional, only students who score well on the test will report it to these institutions. This will cause the average test scores for admitted applicants that are reported to *USNWR* to rise and these institutions will see an improvement in their *USNWR* rankings." (3) Report a trimmed mean. According to Finder (2007): "James M. Sumner, Dean of Admission and Financial Aid at Grinnell College, said a counterpart from a well-regarded institution told him that when computing average SAT scores he excluded the SAT's of students accepted as "development cases," whose grades and test scores are often below average but whose families are likely to make major donations. Mr. Sumner declined to identify the university."

status dynamics, we have found that shifts in the perceived quality of peer schools, net of ego-level variations, impact the future status of a focal school in two ways. Peers, depending on how they are defined and located, show evidence of exerting differing pressures on status change. What are the implications of these findings? We see three, in addition to two guiding questions, for future research.

Implications. Viewed against the backdrop of Merton's chair and mountain metaphors, our results suggest first that future work on status dynamics, and on peer effects more generally, will profit from taking a more deliberately flexible stance toward peer influence. Such a stance allows for the possibility that peers, much like social structure in general (Giddens 1979; Sewell 1992), both constrain and enable. To place theoretical weight only on constraint is to leave hidden the motivational consequences of peers' encroachments. In contrast, although current work on peer influence—whether in the areas of educational achievement (Burke and Sass 2008; Epple, Romano, and Sieg 2003; Hoxby 2000; Mouw 2006) or new-product adoption (Aral and Walker 2012)—almost singularly anticipates contagious peer influence (cf. Hanushek et al. 2003), the strongly zero-sum structure of status contests calls for a dual perspective. In our view, a model of status change that does not account for ecological peer effects for at least some region of the status distribution is overlooking a centrally important process.

Second, following from the preceding claim, we also believe that future studies will profit from giving close attention to a primary, though under-examined, feature of positions in status hierarchies: their *uneven* levels of crowding. While an absence of differentiation has been shown to yield widely divergent outcomes in the context of *USN* rankings of law schools (Sauder and Lancaster 2006), the uneven topography of status hierarchies—in which organizations are clumped closely together in some regions, while sparsely scattered in others—has been largely ignored in prior research. Although in our empirical context there are ties in rank throughout the hierarchy, crowding is increasingly prevalent as one moves down toward the lowest rankings. This feature of *USN*'s "top-down" design also emerges from the "bottom-up" in other contests for status, where processes of cumulative advantage yield a long right-tail and tight crowding on the left (Podolny 2005).

Whatever the sources of this unevenness, this topic in particular merits careful emphasis in future research. On a simple empirical level, it means that neither lagged status nor peers' prior outcomes are sufficient for clarifying the antecedents of dynamics in prestige: considering interactions with measures of local crowding is also vitally important.

More abstractly, on a broader theoretical level, the fact that status positions are differentially crowded raises important questions that must be asked about the *salience* of certain kinds of peers and, by extension, the perceived *worth* (to the status-holder) of a given status position. One such question relates to the possibility that lower-ranked, more tightly crowded positions exhibit more churn not just because neighbors are nearer by design. Specifically, does positional churn *also* result from the "constructed" nature of peers encircling the occupant of a low rank? Compared to structurally equivalent peers originating in the (relatively stable) market for students, peer schools perceived to be artificially induced by a third-party ranker may elicit less strategic attention. In our setting, a focal school might view such peers as illegitimate constructions of *USN*, which would then call into question the worth of its status position relative to these peers. We speculate that the comparative stability in ranks at the top versus the sharp peer-driven churn at the floor may reflect status-holders' different perceptions of their local context. We suspect that such perceptions shape schools' comparative willingness to invest

(Sauder, Lynn, and Podolny 2012) in actions that shield their rank from peers' advances.

Third, our finding that citation-based peers' favorably affect a focal school's future rank (and future average SAT) points to the importance of moving beyond the largely measurement-based depictions of peer influence on status growth and decline that have marked prior work on the subject (Bothner, Smith, and White 2010; Podolny and Phillips 1996). Going back to our inclusion of network-status as a conditioning variable, a defining feature of status—at least for those working from structural perspective—is that it is *affiliation-based*. The notion that peers' prestige "rubs off" on, and thus directly constitutes, a given individual's or organization's status has a long history. In Bonacich's (1987) recursive measure, and in the many empirical studies that have followed (e.g., Podolny 2005), peers' status figures directly in the measurement of status itself: a focal actor's status is calculated as a function of the extent to which that actor receives flows of recognition from others who themselves receive recognition. While studies in this vein thus neatly bring in peer influence via the halo effects built into Bonacich's (1987) measure, they simultaneously overlook an important causal chain: peers advance on a relevant status-marker, a focal actor responds, and that actor in turn advances in standing. This process of status-ascent differs greatly from one in which elites passively receive and reflect the deference of their peers (Turner 1960). The process we have brought into focus instead entails an agentic response to peers, and it brings us to the assertion that peer-driven status ascent is at least partially *earned*. We think that future studies should be careful to disentangle peer effects that stem from simple association from those that stem from an active response.

Questions from two counterfactuals. We close by briefly examining two counterfactual scenarios, each involving a plausibly different set of tournament-level features from those characterizing *USN*'s national rankings. In these scenarios, we anticipate peer effects that differ significantly from those we have identified. We sketch these scenarios, together with corresponding questions, to indicate points of departure for new research on status change.

(1) How do peers affect positional changes in middle-status status contests? Envision first a tournament that is *itself* middle-status (Phillips and Zuckerman 2001). That is, it sits below the most esteemed tournaments in its field. The status tournaments we have examined are high-stakes contests comprised of most of the world's top schools (Hansmann 1999). But of course not all contests themselves reside at the top of a hierarchy of *other* such contests. What transpires at different levels of this second-order plane—in which ranking systems are themselves at least implicitly ranked—is important for future status research to consider. There are differences in status not just within, but also between, hierarchies, and these differences warrant focus because of their likely consequences for status-related behavior.

As an example of these second-order comparisons, consider that, in the world of *USN* alone, there are rankings of regional (and now even for-profit) schools. These middle-status systems, although certainly taken seriously by their incumbents and their audiences, are comprised of regional schools and are appreciably lower in standing than the national contests on which we have focused thus far. It is easy to imagine that some, or even many, of the incumbents of these middle-status systems are keenly aware of their standing not just locally, with respect to those in their narrowly circumscribed contest, but also more globally. This would likely be viewed as an unfavorable comparison against those "ranked up" in the next contest.

For such scenarios, we offer two falsifiable predictions. First, we anticipate discernibly weaker ecological effects: no school wants to be overrun as it seeks to cross over to the next status tournament. Second, we expect significantly stronger contagion effects: most schools will even more strongly embrace competitive pressure for the sake of its mobility-related benefits. In situations where the specter of lower standing in an already lower-status tournament is felt, organizations and individuals alike will not easily allow for displacement.

(2) How do peers affect positional changes in status contests that simultaneously span multiple hierarchies? Imagine finally a set of individuals or organizations jockeying for ranks in several status contests at the same time. Unlike the schools in our panel, which orient almost exclusively to *USN*, contestants for status in such domains must navigate a more complex terrain. Consider, for example, business schools competing each year for positions in several tournaments—those run by *BusinessWeek, The Financial Times*, *Forbes*, and *The Wall Street Journal*, among several others (Sauder and Espeland 2006). Each of these entities is a credible ranking body, and each commands the attention of the schools they rank.

While replicating our models for the regional schools just mentioned is unproblematic, modeling peer effects for business schools traveling through multiple hierarchies presents several intriguing challenges, both analytically and theoretically. First, one would have to estimate a system of equations, given the array of rankings in which business schools compete concurrently for positions. Second, a theory of (especially rank-based) peer effects would have to consider ramifications of the *absence* of structural consolidation (Blau and Schwartz 1984). Schools' ranks across the various tournaments will at best be imperfectly correlated: ranking reasonably well in *BusinessWeek* is no guarantee of attaining comparable standing in *Forbes*.

This feature poses interesting questions about *which* peers in *what* rankings most strongly rivet a given school's attention. We expect that, in addition to anchoring strongly on citation-based peers (assuming applicants' choices are reasonably stable), a given school will attend primarily to rank-based peers in the system in which that school ranks most favorably. This brings us to three predictions for future research: strong contagion effects for citation-based peers in the ranking system of primary focus; weak ecological effects from rank-based peers in that same system; and remarkably strong ecological effects in *other* ranking systems. Such ecological effects may at times induce such sharp and surprising cross-system differences in ranks (Stryker and Macke 1978) that new peers come forcibly into focus. Considering these possibilities for peer-identification, we believe there is much intriguing new work to be done.

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Table 1. Selected College Rankings & SAT Scores, 2005 and 2012

	2005	SAT		2012	SAT
1	Williams College	1410	1	Williams College	1420
2	Amherst College	1430	2	Amherst College	1440
2	Swarthmore College	1435	3	Swarthmore College	1435
4	Wellesley College	1355	4	Pomona College	1470
5	Carleton College	1390	5	Middlebury College	1385
5	Pomona College	1455	6	Bowdoin College	1405
7	Bowdoin College	1365	6	Carleton College	1400
7	Davidson College	1355	6	Wellesley College	1375
9	Haverford College	1370	9	Claremont McKenna College	1410
9	Wesleyan University	1375	10	Haverford College	1395
11	Middlebury College	1430	11	Davidson College	1345
12	Vassar College	1375	12	Washington and Lee University	1385
13	Claremont McKenna College	1395	12	Wesleyan University	1388
13	Smith College	1260	14	United States Military Academy	1245
13	Washington and Lee University	1370	14	United States Naval Academy	1250
16	Colgate University	1350	14	Vassar College	1385
16	Grinnell College	1345	17	Hamilton College	1385
16	Harvey Mudd College	1460	18	Harvey Mudd College	1485
19	Colby College	1345	19	Grinnell College	1345
19	Hamilton College	1320	19	Smith College	1305
21	Bryn Mawr College	1300	21	Bates College	1325
22	Bates College	1340	21	Colby College	1343
23	Oberlin College	1340	21	Colgate University	1365
24	Mount Holyoke College	1290	24	Oberlin College	1390
24	Trinity College	1310	25	Bryn Mawr College	1295

Table 2. Correlations and Descriptive Statistics for Variables in Analyses

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Rank	1												
2. Alpha	0.2033	1											
3. Avg SAT	-0.1032	-0.0522	1										
4. Tuition	0.084	-0.2056	0.1116	1									
5. Weighted Rank Difference	-0.1738	-0.832	0.0802	0.3217	1								
6. Network Status	-0.0117	0.014	0.0042	-0.0292	-0.013	1							
7. Cited Alters' Network Status	0.0096	-0.0298	0.0431	0.1563	0.0149	0.0506	1						
8. Zero Out-Degree	-0.0246	0.0285	-0.0485	-0.1748	-0.0512	-0.0012	-0.4362	1					
9. rankpeerSAT	-0.8391	-0.3094	0.1567	0.1024	0.2878	-0.0054	0.0313	-0.0523	1				
10. citepeerSAT	-0.1374	-0.0161	0.1458	-0.1452	-0.0687	0.0771	0.107	-0.3112	0.2525	1			
11. citepeerSAT (Time-Constant Distances)	-0.1618	0.0158	0.1278	-0.2811	-0.1198	0.0359	-0.0201	0.0158	0.2262	0.9004	1		
12. Peer Score	-0.0202	-0.4221	0.0513	0.3755	0.4275	-0.0421	-0.0138	-0.0405	0.159	0.0132	-0.048	1	
13. Alumni Giving Rate	-0.1152	0.0874	0.0488	-0.3637	-0.128	0.0278	-0.0485	0.0721	0.0406	0.1046	0.157	-0.2212	1
Mean	119.75	0.37471	1159.05	19485.5	14.916	0.45323	0.91799	0.19071	1145.99	1140.74	1139.93	2.93983	0.21926
Standard Deviation	70.4005	0.48411	137.91	12092.6	11.3761	1.14034	1.53868	0.39282	103.261	11.2757	11.1596	0.71755	0.1341
Min	1	0	610	776*	2.71683	0	0	0	969.268	1106.61	1105.95	1.3	0
Max	230	1	1525	53110	48.053	12.8314	9.61582	1	1380.49	1171.86	1170.75	4.9	0.67

Note: Within-school correlations reported. Barea Collge in Kentucky offers full scholarships to all enrolling students (approximately 1,500). They reported an average tuition of $776 for 2008 and 2009, which is the minimum in our panel. The next-lowest is $2,258, the in-state tuition for Middle Tennessee State University in 2006.

Table 3. Estimates for Fixed Effects Models Predicting Change in USN Rank, 2006-2012

Variables	1	2	3	4	5	6a	6b	6c
Rank	-0.805**	-0.805**	-0.714**	-0.818**	-0.696**	-0.696**	-0.696**	-0.696**
	(0.0197)	(0.0197)	(0.0396)	(0.0199)	(0.0397)	(0.0666)	(0.0895)	(0.0599)
Alpha	2.791*	-2.567	-1.903	-2.912	-2.069	-2.069	-2.069	-2.069
	(1.107)	(2.241)	(2.253)	(2.236)	(2.244)	(2.516)	(2.460)	(1.663)
Avg SAT	-0.0261*	-0.0242*	-0.0262*	-0.0200	-0.0220*	-0.0220	-0.0220	-0.0220*
	(0.0106)	(0.0106)	(0.0106)	(0.0106)	(0.0106)	(0.0140)	(0.0175)	(0.00789)
Tuition	-0.000818**	-0.000782**	-0.000715**	-0.00101**	-0.000957**	-0.000957**	-0.000957**	-0.000957*
	(0.000142)	(0.000143)	(0.000145)	(0.000153)	(0.000154)	(0.000174)	(0.000175)	(0.000269)
Weighted Rank Difference		-0.295**	-0.279**	-0.337**	-0.323**	-0.323**	-0.323**	-0.323*
		(0.107)	(0.107)	(0.107)	(0.107)	(0.0938)	(0.105)	(0.111)
Network Status		-0.963	-0.897	-0.410	-0.222	-0.222	-0.222	-0.222
		(0.953)	(0.952)	(0.960)	(0.959)	(0.621)	(0.513)	(0.376)
Cited Alters' Network Status		0.0695	0.0565	0.0939	0.0805	0.0805	0.0805	0.0805
		(0.395)	(0.395)	(0.394)	(0.394)	(0.239)	(0.281)	(0.152)
Zero Out-Degree		1.093	1.115	-0.895	-1.218	-1.218	-1.218	-1.218
		(1.167)	(1.165)	(1.261)	(1.262)	(1.135)	(1.479)	(1.458)
rankpeerSAT			0.0684**		0.0930**	0.0930*	0.0930**	0.0930*
			(0.0257)		(0.0261)	(0.0375)	(0.0316)	(0.0257)
citepeerSAT				-0.167**	-0.197**	-0.197**	-0.197**	-0.197**
				(0.0409)	(0.0416)	(0.0522)	(0.0445)	(0.0360)
2007	0.706	0.742	0.515	1.519*	1.348	1.348	1.348	1.348
	(0.735)	(0.741)	(0.745)	(0.763)	(0.763)	(0.974)	(0.994)	(1.316)
2008	6.273**	6.301**	5.569**	8.775**	8.219**	8.219**	8.219**	8.219
	(0.819)	(0.831)	(0.874)	(1.026)	(1.036)	(1.775)	(1.512)	(3.481)
2009	6.680**	7.065**	6.386**	7.203**	6.304**	6.304**	6.304**	6.304
	(0.880)	(0.901)	(0.935)	(0.899)	(0.932)	(1.215)	(1.356)	(2.871)
2010	7.270**	7.669**	6.769**	8.143**	7.003**	7.003**	7.003**	7.003
	(0.981)	(1.003)	(1.057)	(1.006)	(1.054)	(1.551)	(1.573)	(2.767)
2011	8.122**	8.412**	7.297**	9.943**	8.699**	8.699**	8.699**	8.699
	(1.079)	(1.098)	(1.174)	(1.157)	(1.206)	(2.038)	(1.897)	(3.262)
2012	9.284**	9.533**	8.165**	11.76**	10.30**	10.30**	10.30**	10.30
	(1.268)	(1.284)	(1.381)	(1.391)	(1.448)	(1.962)	(2.046)	(3.785)
Observations	3,198	3,198	3,198	3,198	3,198	3,198	3,198	3,198
R-squared	0.452	0.454	0.456	0.458	0.460	0.460	0.460	0.460

Standard errors in parentheses. Models 6a-6c report standard errors clustered by state, athletic conference, and network cluster, respectively.
** p<0.01, * p<0.05

Table 4. Robustness Checks and Peer Variable Interactions

Variables	7	8	9	10	11
Rank	-0.161	-0.692**	-1.623**	-0.696**	-0.685**
	(0.234)	(0.0397)	(0.165)	(0.0395)	(0.04)
$Rank^2$	-0.00221				
	(0.00161)				
$Rank^3$	2.52e-06				
	(3.61e-06)				
Alpha	-3.692	-2.101	-4.114	3.663	-2.357
	(2.269)	(2.244)	(2.258)	(2.614)	(2.2545)
Avg SAT	-0.0189	-0.0212*	-0.0175	-0.0181	-.0211*
	(0.0106)	(0.0106)	(0.0106)	(0.0106)	(.0106)
Tuition	-0.000980**	-0.00100**	-0.000894**	-0.000848**	-.001**
	(0.000154)	(0.000156)	(0.000153)	(0.000155)	(.0002)
Weighted Rank Difference	-0.368**	-0.331**	-0.405**	4.884**	-.3455**
	(0.107)	(0.107)	(0.107)	(1.234)	(.1075)
Network Status	-0.218	-0.0962	-0.244	-0.160	.0456
	(0.956)	(0.962)	(0.953)	(0.956)	(.9627)
Cited Alters' Network Status	0.110	0.0850	0.196	0.226	.2047
	(0.392)	(0.394)	(0.392)	(0.394)	(.3981)
Zero Out-Degree	-1.187	-1.654	-0.856	-1.074	-1.042
	(1.257)	(1.286)	(1.255)	(1.258)	(1.276)
rankpeerSAT	0.105**	0.0976**	-0.0101	0.131**	.1014**
	(0.0261)	(0.0262)	(0.0315)	(0.0275)	(.0263)
citepeerSAT	-0.196**		-0.188**	-0.200**	
	(0.0415)		(0.0414)	(0.0415)	
citepeerSAT (time-constant distances)		-0.233**			
		(0.0466)			
rankpeerSAT x Rank			0.000921**		
			(0.000159)		
rankpeerSAT x Weighted Rank Difference				-0.00440**	
				(0.00104)	
citepeerSAT x Cluster 1					-.2593**
					(.0574)
citepeerSAT x Cluster 2					-.5310**
					(.1469)
citepeerSAT x Cluster 3					-.1381**
					(.0501)
citepeerSAT x Cluster 4					-.2541*
					(.1003)
citepeerSAT x Cluster 5					-.1994*
					(.0793)
Observations	3,198	3,198	3,198	3,198	3,198
R-squared	0.464	0.417	0.467	0.464	0.462

Standard errors in parentheses. Year Fixed Effects included in all models.
** $p<0.01$, * $p<0.05$

Table 5. Within-School Two-Stage Least Squares Estimates Predicting Changes in Three Rank-Inputs

Variables	1	2	3
	Peer Score	Alum Giving	Avg SAT
Rank	0.00133**	0.000143	-0.163*
	(0.000390)	(9.14e-05)	(0.0666)
Alpha	-0.0543*	0.00589	8.021*
	(0.0221)	(0.00510)	(3.748)
Avg SAT	-2.47e-06	5.14e-05*	-0.628**
	(0.000104)	(2.56e-05)	(0.0180)
Tuition	-4.20e-06**	-1.17e-06**	-0.000115
	(1.53e-06)	(3.59e-07)	(0.000262)
Weighted Rank Difference	-0.000679	7.24e-05	0.259
	(0.00105)	(0.000243)	(0.179)
Network Status	0.00341	-0.000716	-1.997
	(0.00944)	(0.00217)	(1.605)
Cited Alters' Network Status	-0.0145**	-0.000927	0.634
	(0.00387)	(0.000898)	(0.662)
Zero Out-Degree	-0.0864**	0.00127	5.864**
	(0.0128)	(0.00301)	(2.222)
rankpeerSAT	0.000650*	0.000103	-0.0456
	(0.000258)	(6.05e-05)	(0.0440)
citepeerSAT (time-constant distances)	-0.00308**	0.000157	0.328**
	(0.000479)	(0.000107)	(0.0779)
Peer Score	-0.664**		
	(0.0262)		
Alumni Giving Rate		-0.374**	
		(0.0177)	
2007	0.0435**	-0.00156	4.172**
	(0.00754)	(0.00178)	(1.293)
2008	0.0543**	-0.00519*	-5.781**
	(0.0107)	(0.00247)	(1.803)
2009	-0.0264**	-0.00365	4.524**
	(0.00916)	(0.00214)	(1.566)
2010	0.00703	-0.00366	4.959**
	(0.0104)	(0.00244)	(1.779)
2011	0.311**	-0.0103**	5.008*
	(0.0119)	(0.00282)	(2.050)
2012	0.167**	-0.0117**	2.761
	(0.0162)	(0.00342)	(2.467)
Observations	3,198	3,108	3,171
R-squared	0.598	0.16	0.338

Standard errors in parentheses
** p<0.01, * p<0.05

Figure 1. 2005 Applicant Network

Node size is based on school's average SAT score for 2005 (scores range from 710 to 1520). Node color reflects school's eigenvector centrality, with darker nodes denoting higher centrality (scores range from 0 to 1). Isolates are excluded. A directed arrow indicates that the sending school cited the receiving school as an institution to which the sender's students also applied.

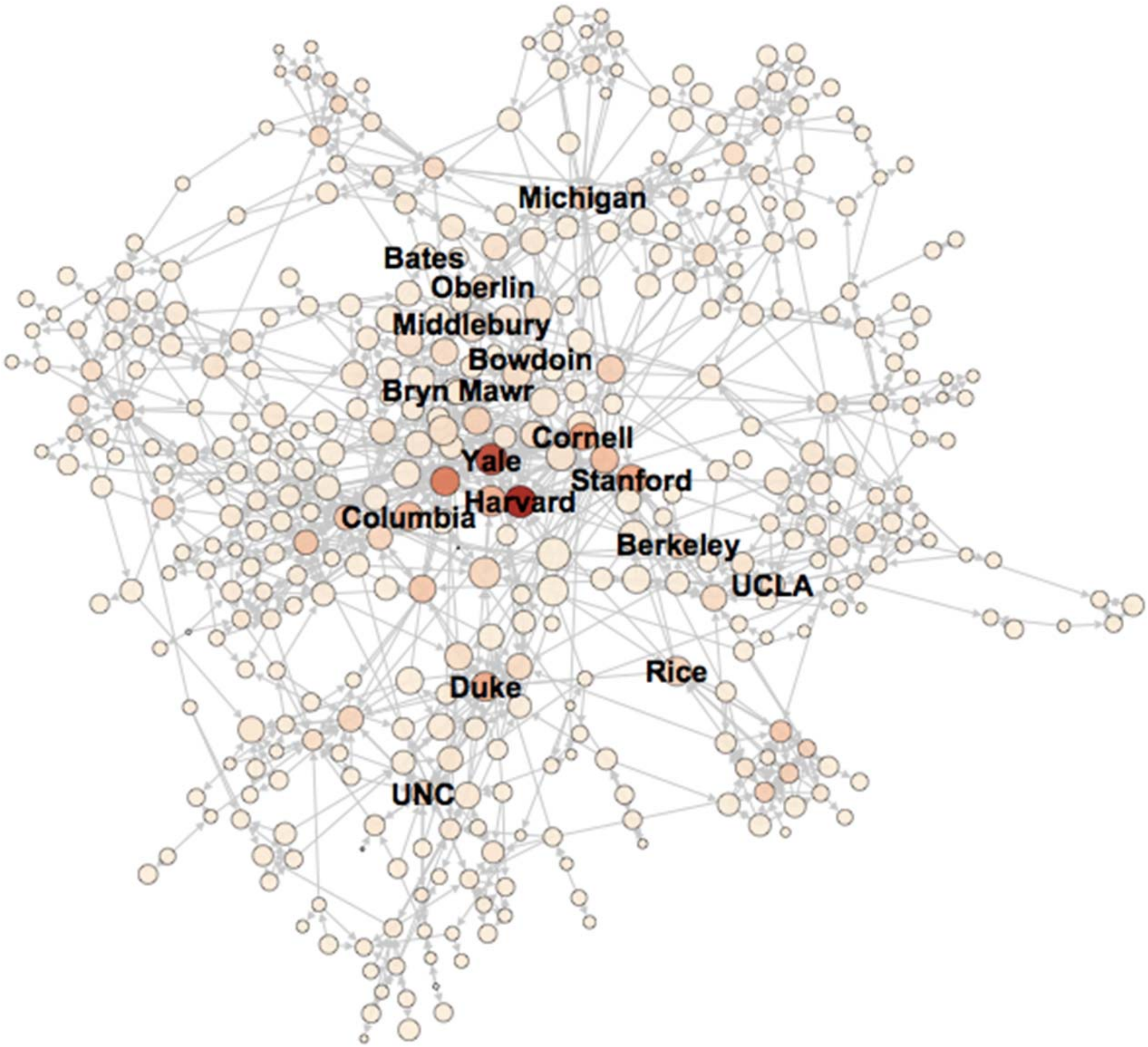


Figure 2. 2005-2011 Applicant Network

Node size is based on school's average SAT score (scores range from 680 to 1520), while node color is based on the school's Eigenvector centrality. Darker nodes indicate higher centrality (scores range from 0 to 1).

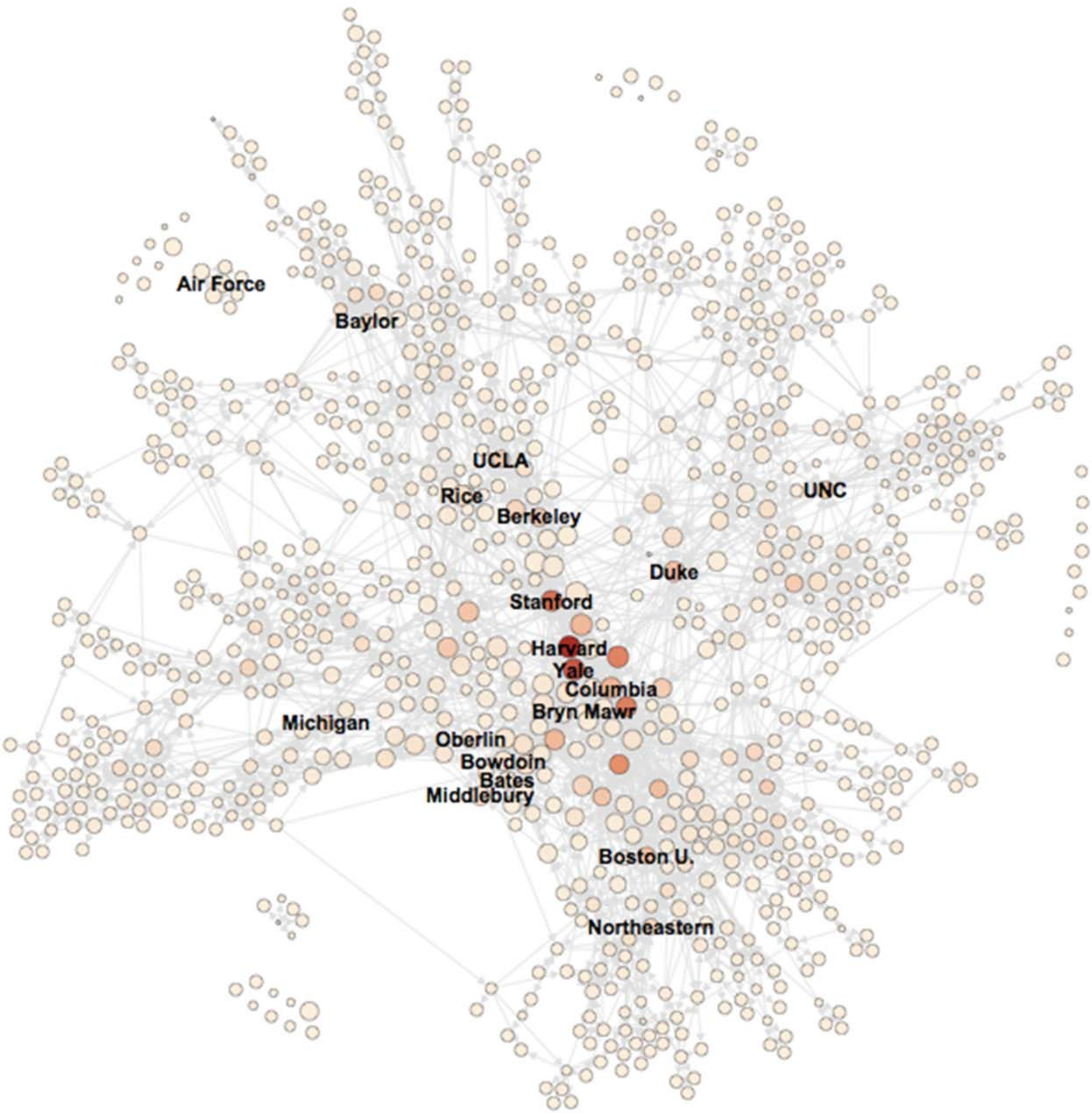
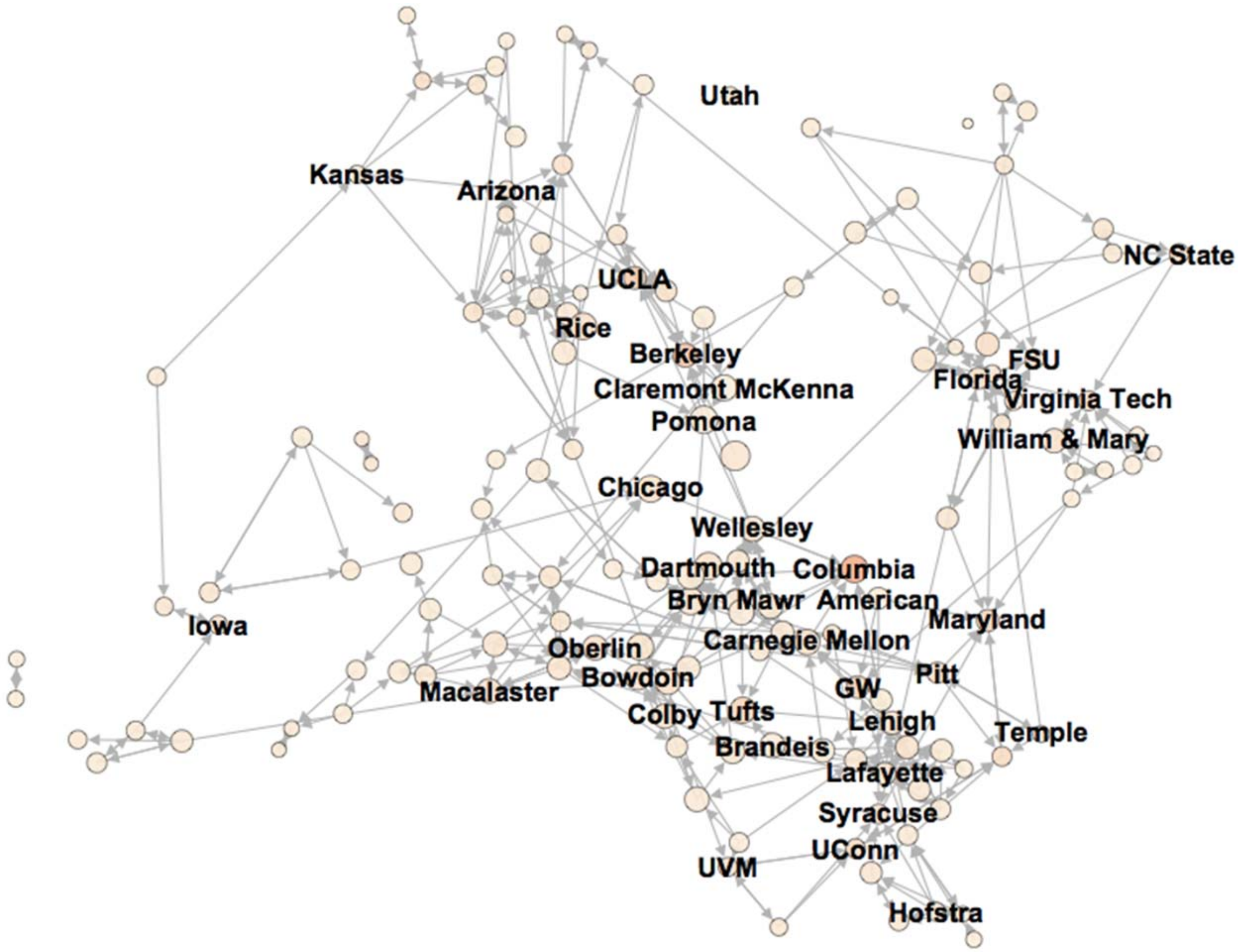


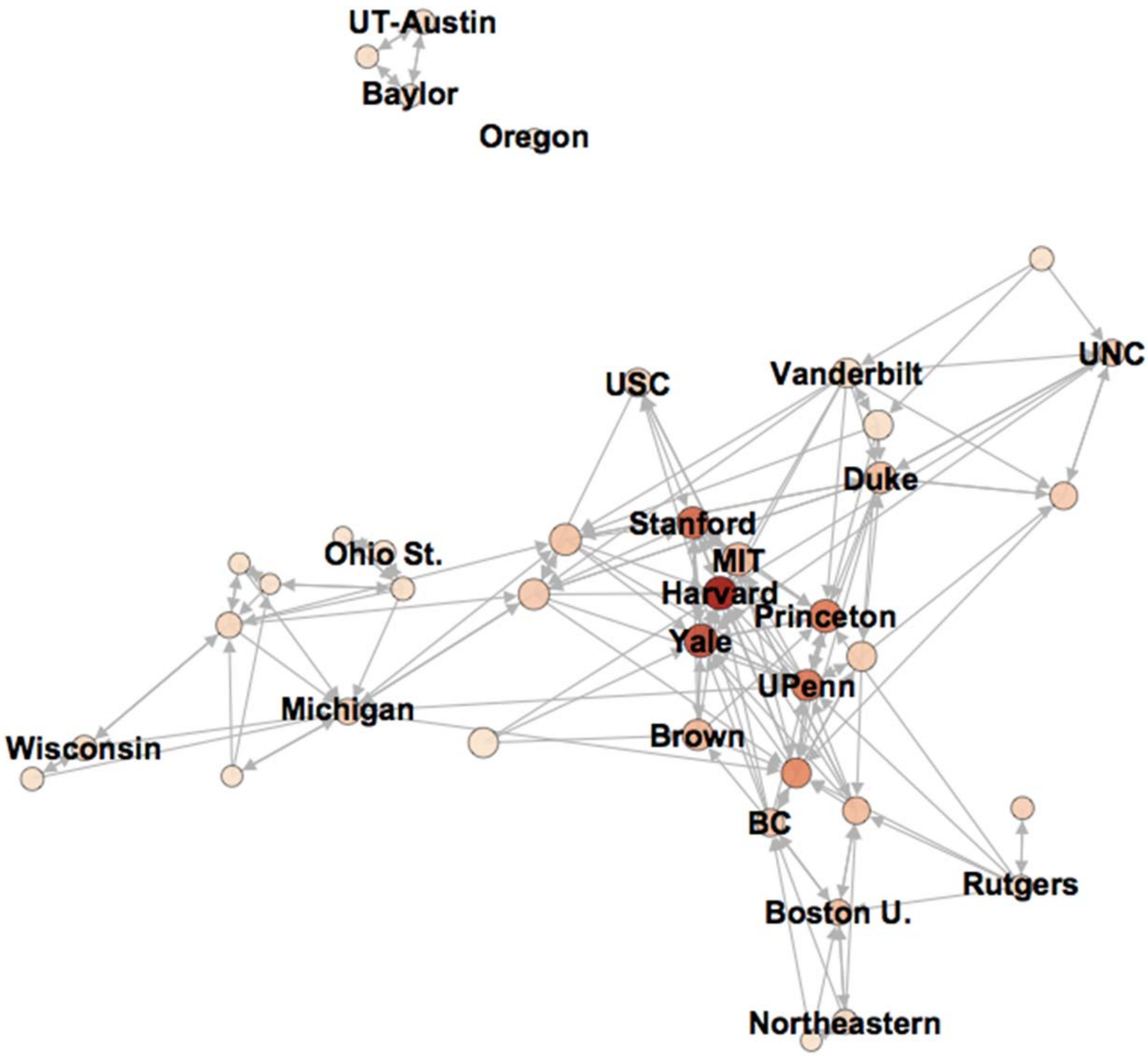
Figure 3. Cluster 1



Cluster 1 Descriptives

Average Network-Based Status	0.4872309
Average Rank	80.35437
Average Tie Strength	0.09179077
Density (Binary Matrix)	0.01760434

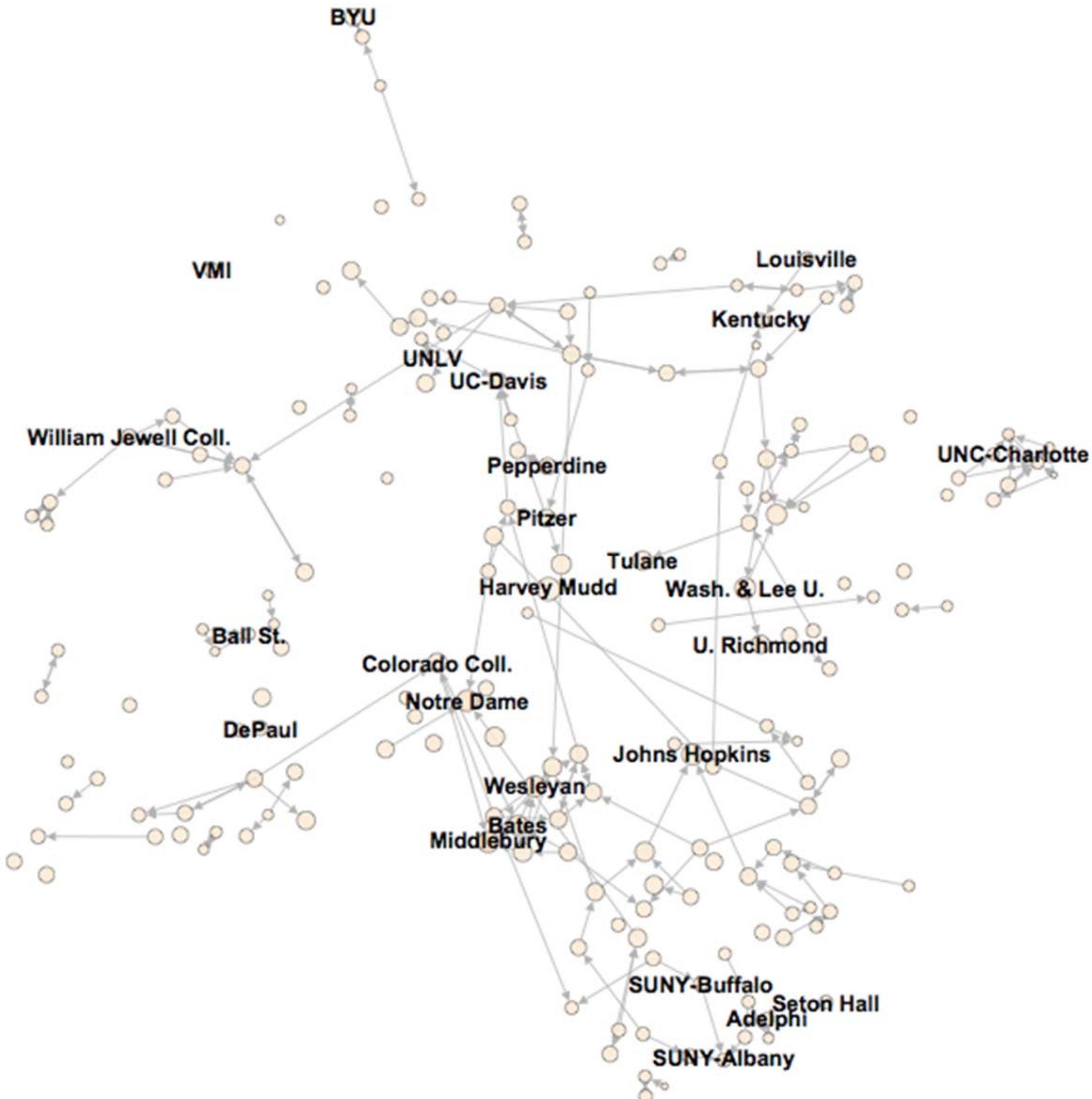
Figure 4. Cluster 2



Cluster 2 Descriptives

Average Network-Based Status	3.029779
Average Rank	40.76429
Average Tie Strength	0.549359
Density (Binary Matrix)	0.1032051

Figure 5. Cluster 3



Cluster 3 Descriptives

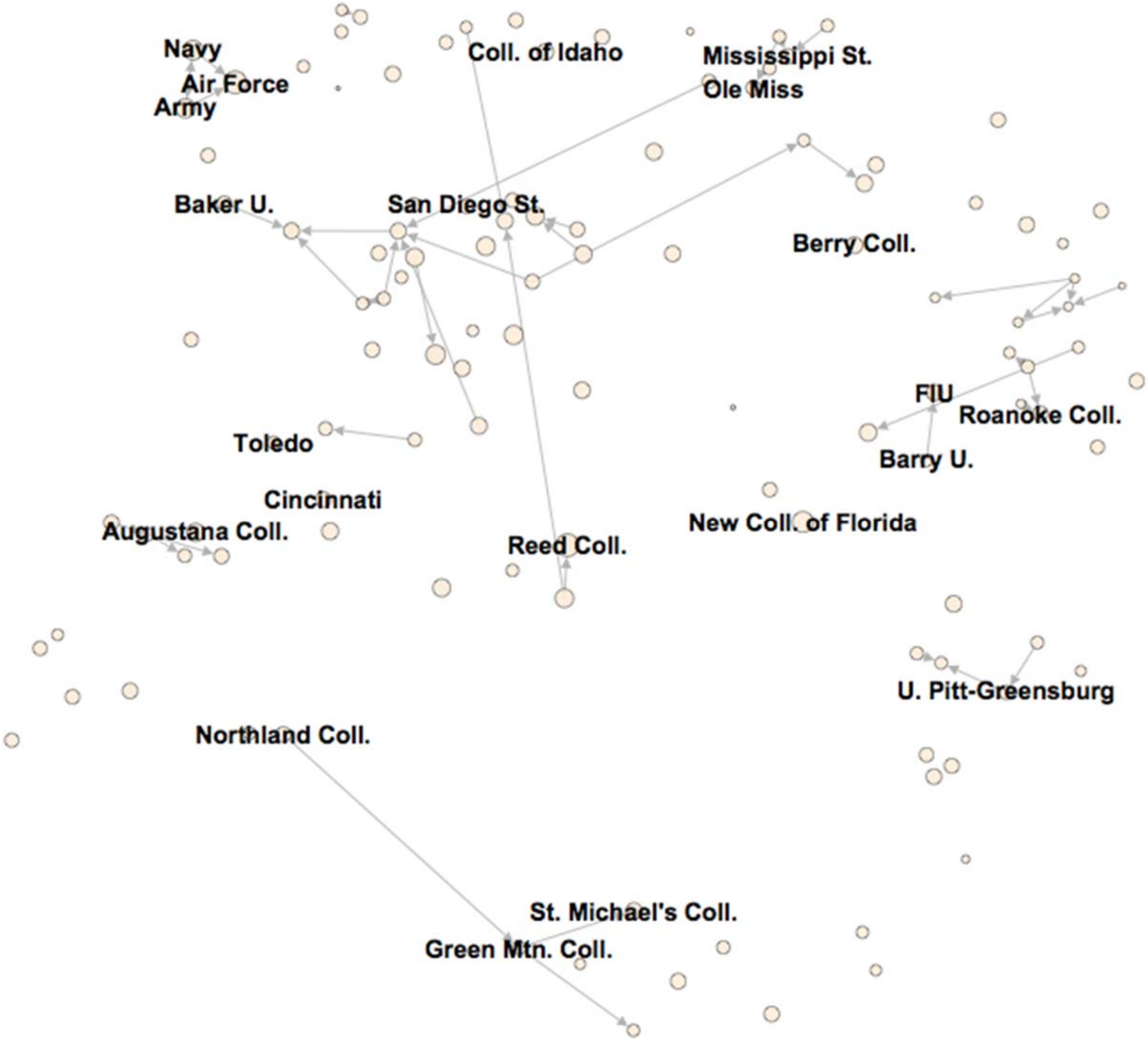
Average Network-Based Status	0.0922062
Average Rank	132.7879
Average Tie Strength	0.02529245
Density (Binary Matrix)	0.005715507

Figure 6. Cluster 4

Cluster 4 Descriptives

Average Network-Based Status	0.0097146
Average Rank	191.3664
Average Tie Strength	0.00050844
Density (Binary Matrix)	0.000395453

Figure 7. Cluster 5



Cluster 5 Descriptives

Average Network-Based Status	0.0695864
Average Rank	175.0518
Average Tie Strength	0.006998479
Density (Binary Matrix)	0.002195175