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Institutional Conflict of Interest: The Role of Interlocking Directorates in the Scientific Relationships Between Universities and the Corporate Sector

We examined the potential for institutional conflict of interest between the 26 private universities belonging to the Association of American Universities and the corporations to which they are tied through their boards of trustees. We were interested in the degree to which interlocks may have tightened over three points across an 11-year period (1994–2005). Our examination relies on a set of patenting profiles estimated from the universities and corporations in our sample. These were derived through a set of organization-event networks that were compared in terms of their structural similarity. We generated these profiles at each of the three time periods. We then measured the degree to which interlocks existed within and between the profiles with the hypothesis that systematically tighter interlocks within profiles may suggest the greater potential for institutional conflict of interest.

As unrestricted monies for higher education constrict, institutions have altered their resource-seeking patterns to compete for new, more competitively allocated funds (Marginson, 2006; National Science Board, 2012; Slaughter & Leslie, 1997). Eager to gain comparative advantage, college administrators and state political leaders increasingly seek out linkages between private sector entities and postsecondary institutions (Geiger & Sa, 2009; Hearn & Lacey, 2009). To respond to new opportu-

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nities, research universities in the United States have also shifted away from basic research toward more applied science and technology—efforts that are considerably more competitive and that can yield more immediate financial returns to the institution (Geiger, 2004; Kirp, 2003; Slaughter & Leslie, 1997; Slaughter & Rhoades, 2004; Suresh, 2011). Private research universities in particular have aggressively concentrated revenues in research expenditures and may increasingly target entrepreneurial science (Leslie, Slaughter, Taylor, & Zhang, 2012). Generally, the presumption has been that on the university side senior management are key actors and leaders in these efforts. In this article, we suggest that private university trustees may also play an important role with regard to increasing universities' participation in entrepreneurial science.

Trustees of private research universities are most often drawn from the business sector, are frequently CEOs of large corporations, are on the boards of directors of other large corporations, and are tightly networked (Pusser, Slaughter, & Thomas, 2006). Given that they are managers and directors of powerful corporations, it would not be surprising if they played a part in shaping strategic decisions at research universities. Because they simultaneously represent both business and universities, networked trustees may be channels between academe and industry that generate synergy that stimulates research, discovery, and technology development leading to economic innovation (Mathies & Slaughter, 2013). However, these synergies also increase the potential for institutional conflict of interest (ICOI).

ICOI refers to situations in which research, teaching, or service are compromised, or appear to be compromised, due to external financial or business relationships held at the institutional level by trustees or senior executives. Efforts to enhance external revenues, whether in the form of payments or donations, by managing universities as firms may result in relationships that have the potential to influence decisions or have the appearance of influencing such activities (Slaughter, Feldman, & Thomas, 2009). As the Association of American Universities (AAU, 2001) states:

Institutional financial conflict of interest . . . may occur when the institution, any of its senior management or *trustees*, or a department, school or other sub-unit, or an affiliated foundation or organization, has an external relationship or financial interest in a company that itself has a financial interest in a faculty research project. Senior managers or *trustees* may also have conflicts when they serve on the boards of (or otherwise have an official relationship with) organizations that have significant commercial transactions with the

university. The existence (or appearance of such conflicts) can lead to actual bias, or suspicion about possible bias, in the review or conduct of research at the university. If they are not evaluated or managed, they may result in choices or actions that are incongruent with the missions, obligations or the values of the university. (p. 2, emphasis added)

We argue that when universities and firms jointly represented by trustees patent in the same classes, this indicates a shared strategic interest in the same technical or scientific research area, creating the potential for ICOI. For example, shared commitment to a research area could lead trustees to prefer investment in some broad fields of science and engineering over others. Or, a trustee who sits on the board of directors of a firm that patents in the same pharmaceutical class as the university s/he represents could take up a license based on a university patent before it is offered to others as a part of a strategy to capture a patent family.

To assess the potential for ICOI, we ask whether there is evidence of increased similarity over time between private research university trustees' corporations and the research of the universities of which they are stewards. We focus on patenting because patents are intellectual property claims that are an indication of interest in entrepreneurial research areas. Trustees' universities and corporations both file for patents. Structural equivalence analyses of the patenting behavior of universities and corporations represented by their trustees reveal patent profiles—that is, groups of universities and corporations that patent in similar classes. Patent classes and subclasses are categories defined by the United States Patent and Trademark Organization (USPTO) based on the technical components of applications.¹ Assignment of a patent to a class means that the patents in the class share a technical and scientific similarity, although each is novel. Thus, if trustees' corporations and universities patent in the same patent profiles, this indicates that there is a potential for ICOI because they share the same intellectual property interests. The potential arises because trustees, who have the power to make strategic decisions, could prefer corporate rather than university or public interests.² Comparison over time of the ties between organizations within a university's patent profile and outside of their patent profile will indicate whether university trustees and the firms they represent are pursuing increasingly similar patenting behaviors. While expansion of shared research areas between universities and trustees' corporations, as indicated by patent activity, has potentially powerful implications for technology development and economic innovation, our interest in this article is limited to ICOI.

Our specific objectives in this article are to: 1) at three periods in time (1994–1997, 1998–2001, and 2002–2005), describe the range of patent behaviors of the 26 private, AAU-member universities and the firms to which they are tied through their respective boards of trustees; 2) during each period, group the 26 private AAU-member universities and the firms to which they are tied based on their patent activity; and 3) assess the extent of board interlocks (i.e., university trustees who simultaneously hold seats on corporate boards) within and between the groups. Through these objectives, we can evaluate the degree to which university-corporation board interlocks are associated with patent activity at the nation's leading private research universities. Our central finding is that the percentage of total ties to patenting corporations within a university's profile grew from 5.61 percent in 1997 to 19.01 percent in 2001 and 26.6 percent in 2005. While 26.6 percent does not indicate systemic patterning of interlocks, it nonetheless suggests the emergence of a trend toward patent profile similarity between universities and corporations to which they are tied.

Literature and Theory

The literature on university trustees is not extensive. Generally, scholars assume that university presidents are the key decision makers and therefore focus on presidents as institutional leaders rather than boards of trustees. The bulk of the literature on boards of trustees is descriptive, presenting trustees' characteristics and offering prescriptive advice to educate trustees so they can better perform their duties (Chait, Holland, & Taylor, 1991; Gale, 1993; Hill, Green, & Eckel, 2001; Ingram, 1995; Jones & Skolnik, 1997; Kerr & Gade, 1989; Madsen, 1997). With the exception of a few descriptive case studies (Bastedo, 2009a, 2009b; Pusser, 2003), there is little empiricism. Most recent studies concentrate on public universities, looking at issues such as affirmative action, trustee activism, and trustee effectiveness (Bastedo, 2009a, 2009b; Kezar, 2006; Pusser, 2004).

The early literature on trustees theorized trusteeship as a vehicle for the control of universities by powerful businessmen (Beck, 1947; Sinclair, 1923; Smith 1974; Veblen, 1918). However, the recent higher education literature on trustees has been largely atheoretical. When theories are employed, they are most often institutional or neo-institutional, sometimes emended to allow for agency/leadership of presidents, governors, legislative staff, and the head of the board of trustees to affirm the overall contours of higher education as an institution (Bastedo, 2009a, 2009b). These theories are usually deployed as interpretations of

behavior in case studies. An exception is Pusser (2003, 2004), who, in a case study of the University of California, argues that trustees are linked to powerful political and economic groups whose interests, to some degree, explain the choices they make.

Networks of trustees have not been fully theorized or empirically studied, nor have trustees' potential ICOIs been studied systematically. We therefore make a significant contribution to the literature by mapping out the ties between private university trustees and publicly traded firms, making explicit the connections between them. By examining this network at three points in time, we are able to ascertain the changing nature of patenting behaviors of universities and the corporations represented by their trustees and the potential implications for ICOI.

We employ three theoretical frameworks to inform our current analysis. First, to examine trustee ties between higher education and corporate industry and the shared research interests of universities and corporations through similarities between patent profiles, we draw on institutional theory. Second, we use academic capitalism to analyze how universities adopt market-facing behaviors through selection of trustees. Third, we draw on neo-institutional theory to examine the unintended consequences university-corporation ties that bridge organizational fields have for ICOI by examining patent activities that are aimed at revenue generation.

Network analysis is often employed by institutional theorists because it offers a way to see how organizational fields are held together. Generally, scholars who model interlocks argue that corporate boards of trustees exercise leadership and influence that shape organizational structure and behavior (DiMaggio & Powell, 1983; Granovetter, 1973; Haunschild & Beckman, 1998; Selznick, 1957; Zajac, 1988). Attention is often focused on the director interlock, the case where individuals serve simultaneously as directors on more than one governing board (Mizruchi, 1996). Studies of interlocks are often based on resource dependence models (Pfeffer & Salancik, 1978) that suggest governing boards are a significant mechanism for pursuing and stabilizing key resources and sources of legitimacy for the organization and that board interlocks are essential to the board's performance in those roles. Director interlocks have been found to generate substantial effects, including increased organizational control over resources and greater interfirm cooperation (Burt, 1983); isomorphic adoption of strategic tactics across firms (Useem, 1984); greater access to information and a reduction of information and monitoring costs; enhanced organizational learning (Mizruchi, 1996); greater access to capital (Stearns & Mizruchi, 1993); and the maintenance of relationships with key resource providers. Utilizing

social network analysis, we are able to examine our primary empirical question: Are board interlocks more prevalent between organizations (corporations and universities) within specific patent profiles than between these profiles? In other words, do universities increase their ties to corporations that patent in the same area over time?

While institutional theory provides a basis for mapping out the relationship within the field, it does not deal well with change (Clemens & Cook, 1999; DiMaggio & Powell, 1991; Zietsma & Lawrence, 2010). Therefore we utilize academic capitalism to tease out the ways in which new institutional and organizational structures that link corporations, universities, and state agencies take advantage of the openings provided by the neoliberal state to move toward the market. Academic capitalism (Slaughter & Cantwell, 2012; Slaughter & Rhoades, 2004) theorizes how segments of universities shift from a public good knowledge/learning regime to an entrepreneurial knowledge/learning regime. The theory sees this shift as occurring incrementally in the United States, starting in the early 1980s and becoming taken for granted by the turn of the century. An emerging organizational field, embodied by networked trustees who share research interests with the universities they govern, may be an intermediating entity that shifts research universities in an entrepreneurial direction. In other words, the intermediating organizational field that joins corporate and university research interests may serve to structure university research efforts to perform more like entrepreneurial corporate laboratories rather than, as was historically the case, research shaped conjointly by academic scientists and federal mission agencies (i.e., Department of Defense, National Institutes of Health, National Science Foundation) (Salter & Martin, 2001; Sampat & Lichtenberg, 2011; Toole, 2012; Varma & Worthington, 1995). If this is the case, analyses of trustee turnover and reappointment should show evidence of selection to maintain and/or increase the number of trustees who represent corporations that are part of the intermediating organizational field.

Neo-institutional theory locates organizations in fields held together by various isomorphisms (e.g., coercive or regulatory, mimetic, normative) (DiMaggio & Powell, 1983) as well as by relational linkages and shared values, cultural meanings, and rule systems (Scott & Davis, 2006). Trustees simultaneously represent corporations on which they sit as boards of directors and the universities of which they are stewards. While trustees share relational linkages with universities, by virtue of their seats on the board, it is not clear to what degree they share cultural meanings and rule systems with them—given that they are leaders in the business world. Generally, business organizations and universities are

conceptualized as somewhat different, and few studies analyze them as part of the same field. Therefore we conceptualize trustees and university managers as representing two overlapping or converging organizational fields. However, organizational fields may change and shift. By studying similarities and differences of patenting behavior on the part of trustees' corporations and the universities they represent over time, we may be able to see if the two fields become more similar with regard to entrepreneurial research (and to what degree) and how these similarities heighten potential for ICOI.

If university patent profiles become more similar to those of their trustees' corporations, then the potential for ICOI increases.³ Trustees who represent both corporations and universities that patent present the potential for double jeopardy. They could prefer university investments that favor shared research areas, or they could draw upon university research to build the science component of their corporate portfolio. There is very little empirical work on ICOI and what does exist has not included trustees (Bartlett, 2008; Campbell et al., 2006; Campbell et al., 2007; Reeser, Austin, Jaros, Bickol, & McCarty, 2008; Weissman, Koski, Vogeli, Thiessen, & Campbell, 2008; Wolf, Catania, Dolcini, Pollack, & Lo, 2008). Therefore our article is a significant and timely contribution to this literature because it allows us to estimate the similarity between intellectual property and research interests of universities and corporations, as evidenced by similar patenting behaviors that are captured in patent profiles. By examining the variation in the trustee ties between universities and corporations within and across patent profiles, we are able to understand more fully the possibility for ICOI between universities and corporations at the highest level of formal organizational authority. Paradoxically, increasing similarity between the research interests of trustees and universities has the potential to contribute to synergies that may stimulate new technologies and economic development in knowledge economies, but it also has the potential to create broad new challenges with regard to ICOI. If we find that the patent profiles of trustees' corporations and the universities they govern become more alike over time, then research-intensive universities may need to rethink the fiduciary responsibilities of trustees to limit potential conflicts of interest.

Data

We limit our analysis in this article to data from the 26 private university members of the AAU from the United States.⁴ Previous research has revealed dramatic differences in the degree of interlocks at private

and public universities that reflect the political, legal, and market realities between public and private sector research universities (Pusser, Slaughter, & Thomas, 2006). Generally, public university trustees are not linked to the dense network that connects most private university trustees. In 2001, for instance, public universities were tied to 113 of the 866 corporations in the network (13 percent). Private universities, by contrast, were tied to 789 corporations in the network in 2001 (91 percent). Therefore our analysis and assertions are restricted to the organization and behaviors of the 26 private AAU members.⁵

We followed three branches of data from the 26 private AAU universities: 1) trustee membership, 2) university-corporate interlocks, which we operationalize as the publicly traded corporations on which trustees held seats on the boards of directors, and 3) patents assigned to universities and trustees' corporations.

First, we collected membership data for the voting members of the universities' boards of trustees (or its equivalent) in 2005, 2001, and 1997. These data were amassed from a variety of sources, including membership lists held at the boards, board Internet sites, and university archives where current and historical board membership files were located.⁶ Second, we identified the memberships of all university trustees on any publicly held corporate board in each of the time periods we examined using filings from the U.S. Securities and Exchange Commission (SEC).⁷ These filings were obtained from the EDGAR (Electronic Data Gathering Analysis and Retrieval) online database, which contains Form 10-K filings on all publicly traded corporations in the United States. The Form 10-K document is filed annually and contains comprehensive information about corporations, including their boards of directors. As a result, we were able to identify trustees' corporate affiliations by searching for their name in the EDGAR database. Third, using the National Bureau of Economic Research Patent Database, which provides data on utility patents filed at the U.S. Patent and Trademark Office, we retrieved data on each patent assigned to the 26 AAU universities and the firms to which trustees were connected as members of boards of directors.

We focused on the years 1994–2005 because these are the years when trustees who represented corporations with science interests became likely to see their universities as a source of entrepreneurial research. As corporations' support of their own research laboratories—for example, Bell Lab, supported by AT&T—has shifted away from basic technology research in favor of research concentrated on product development, they have begun to turn to universities for innovative, entrepreneurial research (Salter & Martin, 2001; Sampat & Lichtenberg,

TABLE 1
Sample for Each Wave (1994–2005)

	Wave 1		Wave 2		Wave 3	
	Firms	Universities	Firms	Universities	Firms	Universities
Total organizations	921	26	789	26	647	26
<i>n</i> with valid patent events	388	26	342	26	225	26

2011; Toole, 2012; Varma & Worthington, 1995). By the mid-1990s, the contributions universities could make to American competitiveness and economic innovation were well understood, and federal mission agencies had shifted large amounts of funding to entrepreneurial and transitional science. Given the staggered appointment of trustees to university boards, it may have taken until 2005 for science corporation trustees to appear and have an impact on board policy.

The time frame for this analysis is delimited into three periods (1994–1997; 1998–2001; 2002–2005). During each period, we coded the patents assigned⁸ to universities by the USPTO. We limit the data to include only patents in classes where at least 25 percent of the universities in our sample hold assigned patents.⁹ Groups of organizations that exhibited similar patenting behavior were then developed using a structural equivalence method we describe in the next section. We characterize the total number of organization in our sample at each wave as well as subset of the waves that patent in Table 1.

Methods

Our primary empirical question is straightforward: Are board interlocks more prevalent between organizations within specific patent profiles than between these profiles? Our analysis, presented below, proceeds in three distinct steps. First, we profile interlocked universities and firms on the basis of their assigned patents. We believe these patents represent the broad intellectual orientations, interests, and expertise of a corporation or university. Second, we assess the profiles over time by examining the patent classes that define the profiles over an 11-year period, 1994 through 2005. Third, we examine the university-corporation interlocks within and between profiles to assess the degree to which interlocks overlap with shared patent classes of universities and corporations, which allows us to assess the degree to which trustees and directors are positioned to align the interests and needs of the corporations and universities they simultaneously represent. Through these

three steps we provide a rich, grounded description of the similarities and differences in the structure of patenting behavior among universities and corporations.

We employ a network-based approach to define an organizational field (Wasserman & Faust, 1994). This approach relies on organizational relations as the basis for the definition of positions within that field. Typically one thinks of relations as occurring between two individuals or two organizations. On the organizational level, a common board member providing an interlock at the board level could connect two organizations. A second type of relationship that can link organizations in a field are shared events. If two organizations participate in the same event, the event ties them together. At the organizational level, an event like a trade association conference could be viewed as tying organizations to one another—that is, there is something about the conference that was sufficiently attractive to participating organizations to warrant their sending representatives. In our analysis, shared events occur when the USPTO assigns university and corporate patents to the same class. Shared participation in such events signals a potential commonality of interest, purpose, and behavior of organizations represented in the specific substantive patent class—thus providing the basis for the definition of our organizational field. These linkages are captured in what is known as a hypergraph that can be described by matrix $\mathbf{H} = [h_{ik}]$, with N organizations and K events:

$$\mathbf{H} = \begin{Bmatrix} h_{11} & \dots & h_{1k} \\ \vdots & \ddots & \vdots \\ h_{N1} & \dots & h_{Nk} \end{Bmatrix}$$

where h_{ik} indicates the relationship of organization i to event k . We assign binary values to any h_{ik} to indicate the presence or absence of a link between an organization and an event. With a hypergraph, positions within the organizational field are based on the similarities of organizations' profiles of linkages to patenting events. Organizations that are structurally equivalent in a hypergraph have identical sets of linkages to specific patent classes. This hypergraph approach has been used at the individual level (Friedkin & Thomas, 1997) and is closely related to the work of numerical taxonomists who cluster units (animals, plants, commercial products, etc.) on the basis of unit-level attributes and behaviors (Arabie & Hubert, 1992; Sneath & Sokal, 1973).

We define the positions of organizations in this way through two steps. First, coefficients of profile similarity are obtained for each pair

TABLE 2
Event Hypergraph of Two Organizations

Event	x_1	x_2	...	x_k
Organization i	h_{i1}	h_{i2}	...	h_{ik}
Organization j	h_{j1}	h_{j2}	...	h_{jk}

of organizations in the hypergraph (i.e., the rows), and second, clusters of similar organizations are formed (similar in terms of their connections to the patent classes that define the organizational networks). The event-profiles of two organizations i and j are expressed within the hypergraph simply, as shown in Table 2. In this table, hk identifies the K events (specific patent classes applied to) to which the organizations might be linked. In a population of N organizations, there will be $N(N - 1)/2$ pairs of such profiles to evaluate in terms of a measure of their similarity. The result is an $N \times N$ matrix of (dis)similarity scores among the organizations. Through this method, similar organization profiles are combined into a discrete set of “distinctive” profiles.

Using this approach we construct an image of organizational similarity from the pattern of organizations’ concrete behaviors and linkages with patent application events. It entails no assumptions that organizational relations and events are arranged in a particular way; instead, the pattern of organizational similarity is revealed empirically from an analysis of the observed individual differences and similarities among organizations. In effect, rather than defining organizations in terms of some nominally defined categorization of patenting or intellectual property production, we use the organizations’ patent class participation to generate patent profiles that each have distinctive combinations of patents. These profiles reveal major lines of organizational differentiation by allowing us to see which organizations pursue a given patent profile. Our approach here also allows us to determine the degree to which the interlocking boards of universities and corporations map onto these patent profiles.

Results

*Dominant Patent Classes*¹⁰

The patent classes are the basis for establishing profiles. A summary of the patent data analyzed appears in Table 3. The last row in Table 3 shows the total number of classes to which USPTO assigned patents

TABLE 3
Summary of Successful Patent Applications

	Wave 1	Wave 2	Wave 3
Total number of patent classes applied to	397	394	379
Average number of classes applied to, overall	19.7	19.6	17.7
Average number of classes applied to, universities only	38.9	41.9	27.6
Average number of classes applied to, firms only	18.4	17.9	16.5
Total number of university-dominant classes ^a	50	63	34

^aUniversity-dominant classes are those in which at least 25 percent of our sample universities applied for a patent.

in dominant classes used in our analysis at each time point. Taken together, the information displayed in Tables 1 and 3 reveal the dimensions of the hypergraphs outlined in the previous section. For example, in Wave 1, there are 414 organizations (388 corporations and 26 universities) that share 50 patent classes, indicating a 414 x 50 hypergraph. Waves 2 and 3 yield hypergraphs of size 368 x 63 (organization x event) and 251 x 34, respectively. The remaining content in Table 3 reveals a fairly stable range of assignments across classes (ranging from a low of 379 in the 2002–2005 wave to a high of 397 in the 1994–1997 wave).

Table 4 below displays the top 10 patent classes for which corporations applied in each of the three waves. The percent patenting in class refers to the proportion of patenting corporations that were assigned patents in the class in each wave. There is both overlap and diversity in the dominant classes¹¹ in which corporations patent across each of the three waves as demonstrated by both the continuity and occurrence of new patent classes in each wave.

The leading patent classes for universities (see Table 5) have greater stability over time than the patent classes of corporations displayed in Table 4. A comparison of the percentages in the two tables shows that there is greater diversity in the patent areas of the corporations, indicated by the much lower proportion of corporations participating in the university-dominant patent classes. This is not surprising given that corporations patent in a wide variety of areas that are beyond the scope of the highly specialized areas of advanced science and engineering on which university research generally focuses. From this we can deduce that the patent classes where both corporations and universities patent likely represent the scientific interests of the corporations, as opposed to their wider interests, which undoubtedly include patents for an array of products relevant for production and manufacturing.

TABLE 4
 Leading Patent Classes of Firms by Wave

Patent Class	Percentage Patenting in Class
Wave 1 (<i>n</i> = 414)	
Stock Material/Miscellaneous Article	24.23%
Measuring/Testing	20.10%
Adhesive Bonding/Miscellaneous Chemical Manufacture	18.81%
Metal Working	17.53%
Plastic/Nonmetallic Article Shaping or Treating: Processes	17.53%
Liquid Purification/Separation	16.75%
Coating Processes	15.98%
Radiant Energy	15.98%
Communications: Electrical	15.72%
Data Processing: Generic Control Systems/Applications	14.95%
Wave 2 (<i>n</i> = 368)	
Stock Material/Miscellaneous Articles	21.35%
Data Processing: Measuring, Calibrating, or Testing	20.18%
Coating Processes	17.84%
Measuring/Testing	17.84%
Electricity: Measuring/Testing	17.84%
Data Processing: Generic Control Systems/Applications	17.84%
Adhesive Bonding/Miscellaneous Chemical Manufacture	17.84%
Data Processing: Financial/Business Practice	17.84%
Plastic/Nonmetallic Article Shaping or Treating: Processes	16.67%
Metal Working	16.67%
Wave 3 (<i>n</i> = 225)	
Data Processing: Measuring, Calibrating, or Testing	22.22%
Stock Material/Miscellaneous Articles	21.78%
Electricity: Electrical Systems/Devices	20.00%
Communications: Electrical	18.22%
Measuring/Testing	17.78%
Metal Working	17.78%
Electricity: Measuring and Testing	17.33%
Radiant Energy	16.89%
Data Processing: Generic Control Systems/Applications	16.89%
Telecommunications	16.00%

TABLE 5
Leading Patent Classes of Universities by Wave

Patent Class	Percentage Patenting in Class
Wave 1 (<i>n</i> = 26)	
Chemistry: Molecular Biology/Microbiology	92.31%
Drug, Bio-Affecting/Body Treating Comp. (Class 514)	92.31%
Drug, Bio-Affecting/Body Treating Comp. (Class 424)	84.62%
Organic Compounds	80.77%
Chemistry: Natural Resins/Derivatives	76.92%
Surgery	69.23%
Stock Material or Miscellaneous Articles	65.38%
Multicellular Living Organisms	65.38%
Coating Processes	61.54%
Electricity: Measuring/Testing	53.85%
Wave 2 (<i>n</i> = 26)	
Drug, Bio-Affecting/Body Treating Comp. (Class 424)	100.00%
Chemistry: Molecular Biology/Microbiology	92.31%
Drug, Bio-Affecting/Body Treating Comp. (Class 514)	92.31%
Chemistry: Natural Resins/Derivatives	92.31%
Organic Compounds	84.62%
Chemistry: Analytical/Immunological Testing	76.92%
Radiant Energy	73.08%
Surgery	69.23%
Image Analysis	65.38%
Optics: Measuring/Testing	61.54%
Wave 3 (<i>n</i> = 26)	
Chemistry: Molecular Biology/Microbiology	92.31%
Drug, Bio-Affecting/Body Treating Comp. (Class 424)	76.92%
Drug, Bio-Affecting/Body Treating Comp. (Class 514)	76.92%
Chemistry: Natural Resins/Derivatives	61.54%
Electricity: Measuring/Testing	53.85%
Semiconductor Device Manufacturing: Process	53.85%
Surgery	53.85%
Radiant Energy	50.00%
Active Solid-State Devices	50.00%
Optics: Measuring/Testing	50.00%

Universities patent classes are quite stable over time in each wave. Although the order varies among the waves, three classes appear in the top three: Chemistry: Molecular Biology/Microbiology; Drug, Bio-Affecting/Body Treatment Compositions (Class 514); and Drug, Bio-Affecting/Body Treatment Compositions (Class 424). Chemistry: Natural Resins/Derivatives also appears in all three waves, as does Surgery. In other words, half of the top ten applications are to the same classes in all three waves, although the percent of universities patenting in the class varies over time. Optics: Measuring/Testing and Radiant Energy appear twice, culminating in Wave 3, as does Electricity: Measuring/Testing, suggesting that university patent applications may converge somewhat over the three waves of our analysis.

Interlocks and Patent Profiles

As outlined above, we used structural equivalence methods to derive the patent profiles of the universities and corporations in our sample in each of the three waves we examine here. Our sample is comprised of 26 universities and 1,007 patenting corporations with which the university trustees have ties. We generate groups of organizations that are assigned patents in the same classes, indicating similar patenting behaviors. If two organizations are in the same patenting profile, this means that they have structurally equivalent patenting behaviors at that point in time. Table 6 provides descriptive information for the profiles for each of the three waves.

Table 6 demonstrates three patterns relevant for our analysis.¹² First, the number of profiles estimated differed in each of the three waves and showed a general decline from Wave 1 to Wave 3, with an exaggerated decline in Wave 2. Second, universities are distributed across the profiles; they are not all in a single profile. This indicates that there are significant differences in the patenting behaviors of universities and that, in a number of cases, the patenting behaviors of universities are more

TABLE 6
Descriptive Information about Patent Profiles

	Wave 1	Wave 2	Wave 3
Number of profiles	11	6	9
Number of profiles that include universities	5	3	6
Proportion of profiles that include universities	45%	50%	67%

TABLE 7

Distribution of Firms and Universities Across the Patenting Profiles

	1997 / Wave 1		2001 / Wave 2		2005 / Wave 3	
	Total	Universities % of Universities	Total	Universities % of Universities	Total	Universities % of Universities
Profile 1	239	0	234	5	154	7
Profile 2	23	0	43	8	24	3
Profile 3	24	4	33	13	12	3
Profile 4	19	1	28	0	28	9
Profile 5	12	0	26	0	4	0
Profile 6	9	1	4	0	2	1
Profile 7	18	3	--	--	7	0
Profile 8	14	0	--	--	10	0
Profile 9	13	0	--	--	10	3
Profile 10	12	0	--	--	--	--
Profile 11	31	17	--	--	--	--

similar to corporations than other universities. This pattern is detailed in Table 7, which shows the distribution of corporations and universities across the different profiles in each wave. The third pattern to emerge is that over time the proportion of patent profiles that include universities increases from 0.45 to 0.67, indicating that over time universities are diversifying their patenting behaviors, effectively becoming a more heterogeneous subgroup over time. This may reflect greater research specialization on the part of individual private universities in an attempt to differentiate themselves from their peers.

Trends in University Ties

The key question that we are interested in is whether universities are changing the nature of their ties to other organizations in a way that indicates a growing potential for conflicts of interest between universities and the corporate boards represented by their trustees. To answer this question, we broaden our focus to the entire sample of university trustees and all of their ties to corporate boards, going beyond the patenting organizations that were profiled.¹³ This allows us to compare three different types of ties: ties to patenting organizations within a university's profile, ties to patenting organizations outside of the university's profile, and ties to non-patenting organizations. By looking at all three groups, we can provide a more complete picture of the ties of university boards.

Figure 1 shows the key trends in university ties across the three waves. There is a marked decline in the total number of ties between universities and other organizations (both other universities and corporations). Despite the overall decline in the number of ties between universities and corporations, there is an increase in the number of ties to corporations that reside in the same profile as the universities (within profile ties). The percentage of total universities ties that are ties to corporations within a university's profile increases from 2.6 percent to 9.9 percent over the three waves.

This increase is even more pronounced when we examine only the university ties to patenting corporations. Figure 2 below displays the percentage of university ties to patenting corporations within a university's profile and patenting corporations outside a university's profile. The percentage of ties to patenting corporations within a university's profile increases from 5.6 percent in Wave 1 to 26.1 percent in Wave 3. We should note that there is a break in the linear trend at Wave 2, where both the number and proportion of within profile ties continued to increase but not as rapidly. We think this is tied to a decline in numbers of

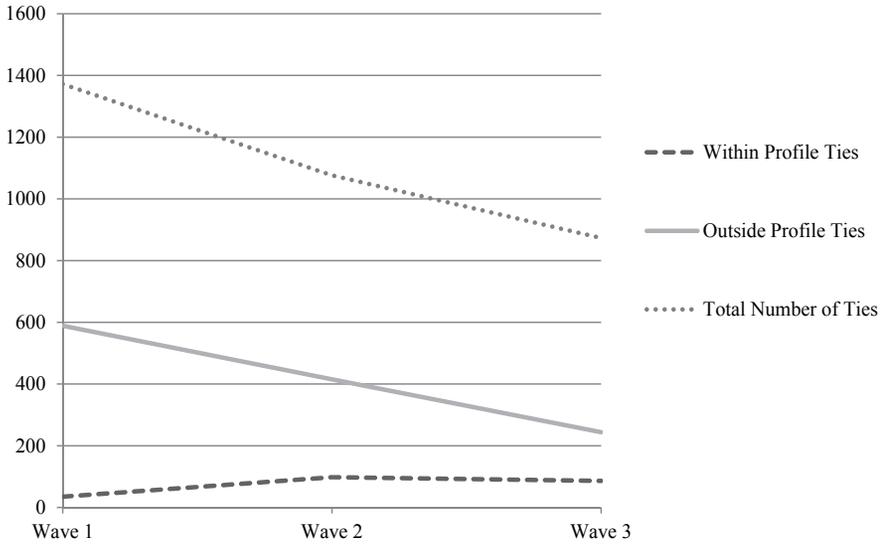


FIGURE 1. Counts of Ties over Time

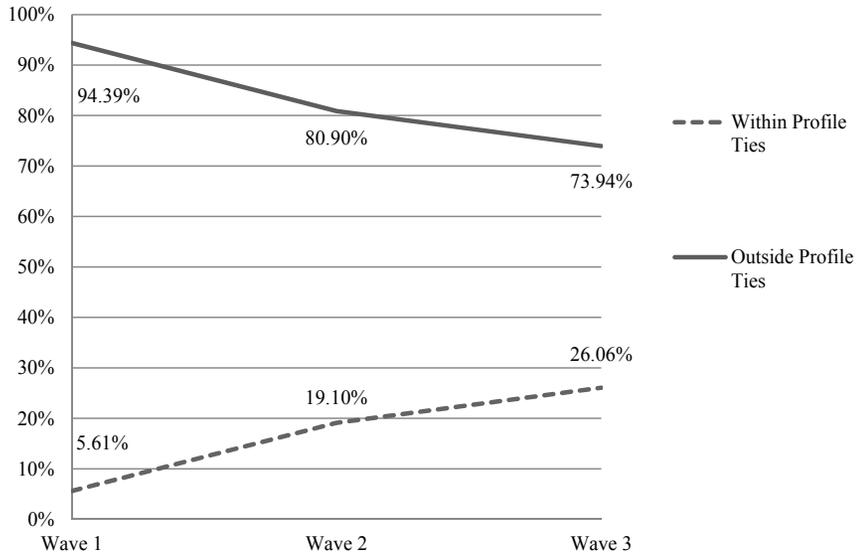


FIGURE 2. Percentage of Profiled University Ties

trustees connected to publicly traded corporations, which we address in the conclusion.

A question that arises when examining the trend in the within profile ties over time is: Are the increases in the number of ties significant? In other words, are the differences in the number of within profile ties between the three waves significant? Given that we are studying the complete population of private AAU universities, tests of statistical significance are not strictly necessary and can only be interpreted descriptively. However, for illustrative purposes, we utilized difference in means t-tests to assess whether the differences across the three waves were significant. The results of the t-tests indicate that the difference in the average number of within profile ties between Waves 1 and 2 and the difference between Waves 1 and 3 are statistically significant. However, the difference in the average number of within profile ties between Waves 2 and 3 is not statistically significant. Substantively, this tells us that there are significant increases in the within profile ties from the beginning to the end of the period, with an incremental increase between Waves 1 and 2 that is significant and that there is no significant increase between Waves 2 and 3. This is consistent with the trends displayed in Figures 1 and 2.

Effectively what this tells us is that in a period of general decline in ties, universities were increasing their ties to corporations that pursued similar patenting behaviors. University ties are becoming more focused or concentrated in the sense that universities were increasingly tied to patenting corporations that pursued similar patenting behaviors. This suggests that, over the period, trustees may be attempting to more closely align corporate and university research interests.

Patent Profiles of Universities: Individual

Now that the overall trends in the university ties have been enumerated, we turn to the over time trends for the individual schools. Table 8 below lists the number of ties between universities and other organizations (both universities and corporations) within their profile for each of the three waves. For example, the first line of Table 8 tells us that Brandeis University had a tie to one organization within its profile in Wave 1, ties to two organizations within its profile in Wave 2, and no ties to organizations within its profile in Wave 3.

Close examination of Table 8 reveals five different trends over time in the number of within profile ties for these universities. We should note that the number of ties varies widely across universities, and therefore we are only interested in the trends over time rather than the magnitude of the university level changes themselves. The first trend is a

TABLE 8
Count of Ties Between Universities and Corporations in Their Profiles

University	Wave 1	Wave 2	Wave 3
Brandeis University	1	2	0
Brown University	0	3	0
California Institute of Technology	2	3	14
Carnegie Mellon University	1	2	0
Case Western Reserve University	2	2	8
Columbia University	1	3	0
Cornell University	2	2	2
Duke University	2	2	2
Emory University	2	0	3
Harvard University	3	2	1
Johns Hopkins University	1	1	10
Massachusetts Institute of Technology	2	26	7
New York University	1	4	1
Northwestern University	3	6	7
Princeton University	1	2	0
Rice University	1	7	0
Stanford University	0	10	6
Syracuse University	1	7	5
Tulane University	0	1	0
University of Chicago	6	2	16
University of Pennsylvania	1	1	0
University of Rochester	1	1	0
University of Southern California	0	1	1
Vanderbilt University	0	2	2
Washington University in St Louis	0	6	1
Yale University	1	0	0

consistent increase in the number of within profile ties over time. Universities that exhibit this trend include: Case Western Reserve University, Johns Hopkins University, Northwestern University, Chicago University, Emory University (it has a slight dip in Wave 2), University of Southern California, Vanderbilt University, and California Institute of Technology. The second trend is also an increase in the number of ties over time; however, it is characterized by an increase in the number of ties between Waves 1 and 2 and then a slight decline between Waves 2

and 3. In effect, the number of ties peaks in Wave 2 and then declines slightly, but the Wave 1 to Wave 3 trend is still positive. The universities that exhibit this trend are: Massachusetts Institute of Technology, Stanford University, Syracuse University, Washington University in St. Louis, New York University (the number of ties in Wave 1 and Wave 3 are equal), and Tulane University (the number of ties in Wave 1 and Wave 3 are equal). In contrast to the first and second trends, the third and fourth trends show declines in the ties between universities and corporations over time. The third trend is characterized by an increase between Waves 1 and 2, followed by a sharp decline between Wave 2 and 3. As with the second trend, there is a peak in the number of ties in Wave 2, but unlike the second trend, the number of ties in Wave 3 is lower than the number of ties in Wave 1—and therefore the overall trend is one of decline. The universities that exhibit this trend are: Brandeis University, Brown University, Carnegie Mellon University, Columbia University, Princeton University, and Rice University. The fourth trend is also one of decline but is a simple continuous decline over time. The universities that exhibit this trend are: Harvard University, University of Pennsylvania, University of Rochester, and Yale University. The final trend is no change over time, and there are only two schools that show no change in the number of within profile ties over time: Cornell University and Duke University.

The summary measures found in Table 8 suggest that the degree of intra-profile connectivity is relatively low. In general, universities are more likely to have a greater number of ties to corporations that exhibit different profiles of patent behavior. This is not unexpected, as boards serve a variety of purposes. What is noteworthy, however, is the generally increasing proportion of interlocks with corporations located within a university's respective cluster. This could indicate that while there is a declining number of interlocks over the time periods we examine here, at least some proportion of those interlocks may be more intentional in terms of aligning the research interests of the universities and the corporations to which they are tied through their trustees.

Trustee Turnover and Reappointment

The ties between universities and other organizations discussed throughout this section are operationalized through the members of a university's board of trustees that are also on other corporate boards. For example, a tie exists between Cornell and Merck if one of Cornell's trustees is also on the board of directors for Merck. Table 9 shows the total number of university ties to corporations and also the total number of university board members for each wave. Two trends are worth

TABLE 9
Number of University Ties and Board Members

Wave	Total Number of University Ties	Number of University Board Members
1	1372	1194
2	1076	1201
3	873	1189

noting: 1) As discussed previously, the total number of university ties declines markedly over time, and 2) the number of university board members remains relatively consistent across the three waves with a slight peak in Wave 2. These trends indicate that overall university board members reduce their ties to other corporations over this period. This makes the increase in the within profile ties to patenting corporations—relative to all ties and relative to ties to non-patenting corporations—even more striking given that it occurs in a period where overall university boards are reducing their ties to other organizations.

Two factors may significantly influence the ties between universities and other organizations: trustee turnover and trustee reappointment. We examined both and found that there was substantial trustee turnover on university boards but not a great deal of reappointment. Only six of the 26 universities reappointed trustees in Wave 3 that were trustees in Wave 1 but not Wave 2.

We conceptualized trustee turnover as the percentage of trustees that were not consistent across all three waves of the analysis. High board of trustee turnover occurs when less than 30 percent of trustees are in all three waves of the analysis, and low trustee turnover is when more than 50 percent of the trustees are in all three waves. There were nine universities that exhibited high trustee turnover with less than 30 percent of their trustees present in all three waves: Harvard University (5.41 percent of trustees in all 3 waves), Princeton University (10.34 percent), Rice University (18.75 percent), Yale University (20.69 percent), Cornell University (21.55 percent), Columbia University (26.47 percent), Duke University (25.47 percent), Stanford University (22.58 percent), and the University of Chicago (29.10 percent). Only three universities exhibited low board of trustee turnover: University of Rochester (51.72 percent of trustees in all three waves), University of Southern California (50.36 percent), and Vanderbilt University (57.14 percent). The fact that 23 out of the 26 universities had fewer than 50 percent of their trustees present in all 3 waves indicates that there is significant trustee turnover during this period. The increase in the within profile ties as a percentage

of university ties to patenting organizations suggests that the new trustees who are appointed to the university boards may play a significant role in the concentration of university ties within their patenting profiles over time. In other words, private AAU university trustees, who are self-perpetuating, select some new board members that are tied to patenting corporations that share research interests with the university.

Discussion

Following institutional theorists who use network analysis to study corporate boards through interlocks, we modeled interlocks between academe and industry to assess the potential for ICOI by examining the ties between universities and corporations in the context of their patenting behaviors, as represented by the patent profiles estimated in this analysis, and how these changed over time. Like institutional theorists who base their work in resource dependence models (Pfeffer & Salancik, 1978), we wanted to see if governing boards were a mechanism for pursuing and stabilizing resources. We focused on patents, which are a resource for universities and corporations that have been unexamined in the corporate board literature to date. For universities, patents are a claim on intellectual property produced by research and discovery stemming from federal grants and contracts. Universities can sell, license, or build start-ups around their patents, generating external revenues that can be used for further research. Patents are resources for corporations because they provide a temporary monopoly on intellectual property, providing competitive advantage that may lead to substantial profits, as, for example, in the pharmaceutical industry. If universities and corporations are assigned patents in the same class, the USPTO has, in effect, guaranteed their similarity. To understand if trustee interlocks are a way of enhancing this resource, we used structural equivalence models to create profiles from the patent classes to which university and corporate patents were assigned to see if they became more similar over time.

Although patents are an elegant way to capture university trustees' and their corporations' shared research interests and the resources that may accrue from them, patent profiles have limitations as a link between universities and corporations. Patents likely capture a limited amount of shared activity because patenting occurs in a relatively narrow band of research and relatively few universities patent. Trustees' corporations and universities may be more tightly linked through consulting, hiring of graduates, and industry-funded research programs and university-industry partnerships than through patents.

Despite the limits of patents as a link, we found that the percentage of total ties to patenting corporations within a university's profile grew from 5.61 percent in 1997, to 19.01 percent in 2001, and to 26.06 percent in 2005. While 26.06 percent does not indicate systemic patterning of interlocks, it nonetheless suggests the emergence of a trend toward patent profile similarity between universities and corporations. In keeping with institutional theorists who see interlocks as a way of seeking and stabilizing resources, patent profile similarity points to patents as a resource that university governing boards pursue in their dual capacities as trustees and corporate directors.

In keeping with academic capitalism and its emphasis on movement towards the market, networked trustees may embody an emerging organizational field, or the growing overlap of two fields, that share research interests with the universities they govern and may shift research universities in an entrepreneurial direction, acting as an intermediating entity that also serves to structure university research to perform like corporate laboratories. If this were the case, we would expect some evidence of trustee selection to maintain and intensify interlocked ties within profiles.

Although specifics of selection processes are not public, we know that private AAU university boards have a broad and deep alumni pool to draw from when searching for trustees to represent corporations with patent profiles similar to the universities. These universities routinely graduate men and women who disproportionately head the central institutions in the United States, ranging from corporations to government (Domhoff & Dye, 1987; Dye, 1989, 1984, 2002). Ten percent of the trustees who were alumni in our 2005 sample were directors of Fortune 500 corporations. Additionally, 30 percent of the university board members in our sample were not alumni, and these trustees had about 1.5 times as many corporate ties as alumni, suggesting that board members may be deliberately chosen because of their ties.

Although there was a great deal of turnover on university governing boards between 1997 and 2005, and few reappointments, there was increase in the within profile ties as a percentage of university ties to patenting organizations. This suggests that the new trustees who are appointed play a significant role in the concentration of university ties within their patenting profiles over time. In other words, private AAU university trustees, who are self-perpetuating, select enough new board members who are tied to patenting corporations that share research interests with the university to increase ties to corporations in their patenting profiles. The strengthening of ties to within profile organizations is all the more notable given the general decline in ties to corporations during the period.

There is also a possibility that intentional selection is underrepresented by our focus on *individuals* who interlock universities and corporations. Universities and corporations can be linked through interlocks as represented by a person—for example, Sam Smith, a university trustee and Merck board member, links the university to Merck—as was the case in our analysis. They can also be interlocked by a corporation—for example, Sam Smith is replaced by John Jones, a new trustee who also sits on the Merck board. In other words, the specific trustee has changed, but the university board is still tied to the corporation. Finally, neither individual nor corporation may be the same, but the industry tie is still there—for example, there is new trustee from Novartis rather than Merck.

Regardless of whether trustees shared ties to corporations that patented in the same profile as universities, we were puzzled by the overall decline in trustees' ties to corporations. The most precipitous decline occurred between 2001 and 2005 from the second to the third wave (see Figure 1). Given the history of university trustees, we would have expected connections to hold steady or increase (Beck, 1947; Pusser, Slaughter, & Thomas, 2006; Sinclair, 1923; Smith, 1974; Veblen, 1918).

The decline in ties may result from changes in government rules and regulations along with the development of new financial instruments—that is, credit default swaps, hedge funds, private equities, and commodities that are classified as “alternative assets” that contribute to a largely privately held “shadow banking system,” which, for a time, provided more lucrative investments than publicly traded corporations (Pozar, Adrian, Ashcraft, & Boesky, 2010). Sitting university trustees may have begun to prefer new trustees with ties to alternative asset companies. Because many of these are not publicly traded, they would have fallen outside the scope of our study. Unlike publicly traded corporations, private equity corporations and many other alternative assets do not have the same reporting requirements and sometimes “go dark”—that is, cease filing with the SEC altogether—or file a short form that does not reliably include information about boards of directors. Because of these reliability issues, we did not attempt to locate trustees in “alternative asset” classes for this analysis. We are, however, analyzing the ties between university trustees and the trustees of these corporations in a current manuscript looking at the changing network ties of public and private nonprofit research universities from 1975 to 2005.

There is substantial evidence that private AAU trustees began to prefer alternative assets following the spectacular success of universities such as Harvard University and Yale University that developed the Endowment Model of Investment (Humphreys, 2010; Leibowitz, Bova, & Hammond, 2010) in the 1990s. This strategy called for heavy invest-

ment in alternative assets and was vigorously pursued by universities characterized by large endowments, location in the Ivy League, students with high SAT scores, and private nonprofit control—beginning in the mid-1990s, becoming noticeable by 2000, and increasing dramatically through 2005 (Lerner, Schoar, & Wang, 2008, see Figure 3, p. 215). The majority of AAU private universities exhibit these characteristics. AAU trustees may have begun to select new trustees for their ability to enhance endowment through non-publicly traded companies beginning in the late 1990s.

Many of the corporations to which AAU private university trustees are tied are in the finance, insurance, and real estate (FIRE) network, which we did not analyze in this article because most of these corporations are non-patenting. Given the many connections of trustees to these publicly traded corporations, it is plausible that trustee selection committees may have sought to enhance endowments through preferring new trustees in similar but privately held corporations in “the shadow banking system” (Poazar, Adrian, Ashcraft, & Boesky, 2010). In other words, the number of trustees’ ties to corporations may not have declined, although the number with ties to publicly traded corporations certainly did. If an increasing number of AAU trustees were selected because of ties to privately held corporations, that makes the continued selection of trustees who have within profile ties all the more remarkable and could indicate boards’ intentionality with regard to maintaining research interests in intellectual property classes they share with their universities—despite the allure of high-risk, high-return alternative assets that may rapidly build endowment.

In sum, there is some evidence of trustee selection to maintain and intensify interlocked ties within profiles. However, trustees may be moving from selection processes that prefer intensifying ties in shared research areas to one that prioritizes ties to privately held, alternative asset corporations likely to rapidly build endowments. Perhaps the more important point is that new trustees are likely selected for strategic reasons, indicating that trustees play an important role in governance.

We advance the neo-institutionalist concept of the organizational field by following field change by focusing on patent profile similarity and dissimilarity. The patent classes reveal the points where trustees’ universities and corporations share organizational fields with similar research interests. In all waves, there was remarkable stability in the classes applied to by the universities and the corporations to which they are connected, yet the classes were quite different. The corporations represented in the various waves patented in four of the same broad classes in each wave: 1) Stock Material/Miscellaneous Articles, 2) Measuring/

Testing, 3) Metal Working, and 4) Data Processing: Generic Control Systems/Applications. They had a much lower percentage than universities in any wave and any class (15–24 percent). Given that corporations are focused on protecting intellectual property embodied in products and processes for mass markets, we would expect them to patent in a variety of broad classes, rather than mirroring the advanced science fields in which universities are more likely to patent.

In contrast, universities applied with greater consistency to a narrower range of patent classes. In all waves, five classes of university patents appear with a relatively high percentage in the class (53–100 percent).¹⁴ University patent activity is much more specialized than corporate, likely reflecting the narrower band of activity on which advanced science and federal funding are concentrated.

The overlaps between corporations and universities, as evidenced by increases in within class patenting, suggests convergence of organizational fields that constitute a shared organizational entrepreneurial science field in the relatively narrow band where advanced science has the potential to be incorporated in mass-market products. In other words, organizational fields have some degree of fluidity. Our study suggests that shared research and interests and shared resources may play a part in how organizational fields change. However, further research will be required to see if senior university managers and trustees who sit on the boards of directors of science corporations are beginning to share values, cultural rules, and meaning systems. Should this be the case, the potential for ICOI may heighten, since differences between managers from the university and corporate sector would be lessened. While shared values, rules, and meaning systems might facilitate shared research interests, technology development, and commercialization, they would confound the purpose of trusteeship, which is to provide stewardship for the university by persons outside the community—who, presumably, are not immersed in it yet can provide the guidance that comes from some degree of separation.

As noted, university ties to other organizations within their patent profile grew from approximately 5.61 percent to 26.06 percent in an 11-year period; this shows convergence rather than field consolidation. However, it is important to note that we took a very conservative approach to our data, and our models are most likely underestimated. Co-patents, held jointly by universities and their trustees' corporations, which accounted for approximately 7% of patents, were not included because they could not be assigned to either universities or corporations unless they were double counted. The corporate jobs held by trustees (e.g., CEO of Merck) were not included in the data set because

we wanted to compare members of boards of directors, who hold final legal, fiscal, and moral authority over corporations, to trustees, who bear the same responsibility for universities. While this choice was appropriate for our research design, we lost a significant point of connectivity between trustees and universities because many trustees are CEOs. By focusing only on individuals as the point of interlock, we lost corporate and industry ties, as discussed above. In short, the ties between trustees, corporations, and industry segments and universities may be much closer than our study suggests, and the organizational fields of trustees and senior university managers, as measured by relational ties, may be more similar than our data indicates. Further research on relational ties may allow us to see more clearly the degree of convergence.

The potential for ICOI occurs when trustees' universities and corporations are tied within patent profiles that occur within the entrepreneurial science field. The AAU trustees who serve on university and corporate boards have the potential for indirect and direct market-related advantages for both parties. Indirect advantage could arise from shared commitment to a particular scientific and technical area that may lead trustees to prefer university investment in broad fields of science related to fundamental research concerns of their corporations, setting up a situation in which the university functions like a corporate lab. While this may benefit both university and corporation with research interests in these fields, and not violate any legal rules, other areas of science—to say nothing of non-science fields—could be disadvantaged. ICOI could also occur, again benefitting both university and corporation if, based on a trustee's assessment of his corporation's research needs, a corporation then sponsored research in an area of shared entrepreneurial research—perhaps with an intent to co-patent should the research seem promising. Again, both university and corporation benefit and no legality is violated, but there is an “appearance” of ICOI, and other university scientists are unable to access these resources.

Conclusion

University patenting occurs in a relatively small number of classes, primarily chemicals, biotechnology and pharmaceuticals, which accounted for approximately half of all university patents in 1998–2008 (NSF, 2010)—therefore, likely occurring in a relatively small number of the broad fields of science. All of these events promise the same potential for synergy contributing to economic innovation and/or ICOI. The standard response in the conflicts literature is that potential conflicts can be managed. However, the potential for ICOI inherent in shared class

patenting by corporations and universities represented by interlocked trustees is one for which we have no well-articulated management rules (Slaughter, Feldman, & Thomas, 2009). If the knowledge economy strengthens, and universities become the source of innovation that policy makers hope for, then the potential for conflicts, individual and institutional, will likely increase. Shared patenting strategies may capture only a segment of the ways in which such conflicts are manifest, but they are nonetheless important because they constitute an important basis of strategic interorganizational coordination in an era of science with only limited barriers between basic and applied research.

We should note that patenting in a common class is only one type of activity that may define the structural relationships between trustees' corporations and the universities they represent. Many other events with the same potential are possible—for example, research funding, consulting arrangements, donor activity, hiring practices, formal university-industry partnerships, test bed relationships, and startups. Trustees who represent corporations and universities who share patent classes may be more likely to participate in such activity because they have shared research interests. For example, they may fund research in interlocked patent profiles, draw on the faculty involved as consultants, and set up the university as a test bed for the product. In other words, sharing a research area with the potential for intellectual property may create multiple possibilities for direct and indirect ICOI, a relatively un-mapped area.

The trend toward greater similarity within patent profiles of trustees' corporations and the universities of which they are stewards raises governance issues in a knowledge economy. Although business leaders have long been on the boards of private research universities, they were historically drawn from the industrial manufacturing sector. Prior to the 1980s, the scientific division of labor was that universities performed basic research, government laboratories were often involved in development, and industry moved products to prototype and the market. The knowledge economy has changed this division of labor so that universities are involved in entrepreneurial research that can rapidly yield intellectual property. Trustees who are on the boards of directors of knowledge economy corporations are able to comprehend, enhance, and utilize research shared with the universities they govern. While shared research interests create synergy that can lead to technology discovery, new knowledge-intensive products, and economic development, that synergy also increases the potential for ICOI. Research-intensive universities may have to rethink the fiduciary responsibilities of trustees in order to ensure governance that attends to all aspects of mission.

Notes

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¹ More information on the more than 400 classes of patents and the subclasses can be found at <http://www.uspto.gov/web/patents/classification/index.htm>

² We examined the extent to which there were interlocks among patent co-assignees, as it constitutes direct potential for ICOI, but the numbers were not great and we did not include them given our focus on profiles, which reflect shared research interests.

³ Conflict of interest (COI) has been studied primarily at the level of individual researchers (Bekelman, Li, & Gross, 2003; Cho, Shohara, Schissel, & Drummond, 2000; Van McCrary et al., 2000), but ICOI is a growing concern for research universities because the increasingly dense web of university-industry interactions, and occasionally partnerships, offer the potential for universities to make selective choices in the pursuit of external revenues that may benefit some segments of universities and their constituents and not others (Association of American Medical Colleges—Association of American Universities, 2008).

⁴ There are two Canadian universities, McGill University and University of Toronto, which are not included in our study.

⁵ The complete list of AAU institutions can be found here: <http://www.aau.edu/about/article.aspx?id=5474>.

⁶ When board officials (usually administrative personnel) were uncooperative, we filed freedom of information (FOIA) requests through our lawyer.

⁷ This data may underestimate corporate representation. Although a number of the private university trustees were also CEOs of corporations, these ties were not included in the data because we wanted parallel authority structures at the highest level of governance of each type of organization—corporate boards of directors and university trustees. Nor were the connections of university presidents, who are often voting members of the university boards, to corporate boards included in the data. Presidents are often members of corporate boards of directors, and sometimes sit on more than one (Goldschmidt & Finklestein, 2001; Slaughter, 1990). Because our focus was on trustees rather than senior management, we excluded presidents' ties to corporate boards. We anticipate that including these other forms of university-corporation ties would strengthen the findings we present below.

⁸ University policy usually requires faculty to disclose discoveries that may be patentable. These discoveries are reviewed by university personnel, and then a decision is made to patent or not. If the decision is positive, then the university applies for the patent. The same process occurs within corporations. The USPTO then evaluates the patent for its novelty. The time this takes is variable, and not all patents applied for are assigned. We reasoned that because assigned patents give the holder control over the intellectual property represented by the patent, they were a better marker of commitment to a scientific area than were applications.

⁹ We made the decision to allow the university-dominant patent classes to drive the definitions of the profiles because the university is our focal point. It made little sense to us to include patents that had little or no relevance to the interests of the universities themselves.

¹⁰ It should be noted that our analysis is descriptive and, because we are working with the universe of private AAU institutions, trustees, and patents, we treat our findings as population values rather than estimates. That is, we do not infer relations based on a sample. Any differences observed in our analyses are treated as real differences in the population we are working with.

¹¹ University-dominant classes are those in which at least 25 percent of our sample universities applied for a patent. A listing of all the university-dominant patent classes is available upon request from the authors.

¹² As a reminder, the profiles are not the same across the three waves; they are substantively distinct. They are simply numbered here to provide a point of reference.

¹³ The distinction between patenting and non-patenting firms is based on the presence or absence of patents in the university-dominant patent classes. Non-patenting firms can still patent; they just are not doing so in the university-dominant patent classes on which this analysis is based.

¹⁴ See Table 5 for the leading university patent classes.

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