Institutional Evolution and the Collaborative Development of Technology Transfer Capabilities

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Abstract
This article examines the development of university technology transfer operations at the Research Triangle region’s three universities. Organized to commercialize university-based scientific inventions, this expertise was essential to university engagement in the region’s long-term development. Early collaborative efforts to jump-start technology transfer in the region were promoted via a joint licensing consortium. Those early efforts—and their eventual devolution to the universities—are critical to understanding the region’s subsequent development. We document a process of competing institutional logics and institutional interpretation, with officials from each campus continually interpreting the collaborative’s value against their own institution’s evolving needs.

Keywords
urban and regional economic development, economic growth and development, policy and applications, universities, organizational change, research and development, innovation, other policy and applications, policy and applications, university technology transfer, TULCO, regional consortium

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Introduction

Regional vibrancy and long-term economic prospects are determined by the degree to which local institutions forge partnerships and work collaboratively on technology development. Within any regional economy, there are often multiple research universities, each with different institutional missions and capacities. Together, these institutions form an informal, regional system of technology development and transfer and are part of the fabric of the ecosystem. Universities may also choose to pursue more formalized, partnered systems. Interuniversity collaborations in the form of sciences parks, innovation hubs, incubators, and new urban campuses continue to increase (Addie 2019). Yet these spaces, including Roosevelt Island’s Jacobs Technion-Cornell Institute, and London’s Nanotechnology Centre, also raise questions about their long-term scientific contributions, such as whether collaborative efforts provide additive benefits—or instead dilute university ecosystems, unintentionally dampening innovation (Donegan and Lowe 2020).

We explore the case of the short-lived Triangle University Licensing Consortium (TULCO) in North Carolina’s Research Triangle region as an illustrative example of interuniversity collaborations. This case reflects the promise and pitfalls of institutional collaboration and shows how university-led technology transfer strategies evolve to act as a catalyst for broader regional economic development. In the years following the passage of the Bayh–Dole Act (Bayh–Dole) in 1980, universities faced uncertainty over how to best respond to the new mandate to actively commercialize discoveries from federally funded research. As part of efforts to jump-start lagging campus commercialization efforts, Duke University (Duke), North Carolina State University (NCSU), and the University of North Carolina at Chapel Hill (UNC) formed TULCO in 1988. Yet TULCO operated with support from all three universities for just five years (1988–1992) and completely dissolved in 1995. As a result of its short existence, TULCO is either overlooked or framed as a doomed experiment in the story of how the Research Triangle region became a center of high-technology innovation and entrepreneurship.

We rely on the theoretical lens of institutional interpretation to analyze how actors from different organizations reconcile competing institutional logics of university technology commercialization. Institutional interpretation refers to the way actors—when faced with considerable gaps between different institutional norms, practices, and policies—frame institutions as lived experiences to iteratively interpret their daily activities and decisions, and through doing so either create a new institutional logic or nurture the creation of coexisting logics (Lowe and Feldman 2017). In this case, Bayh–Dole created a formal, legal institution of technology transfer and the reality that each university needed to be more entrepreneurial; TULCO gathered universities with unique informal institutional arrangements of technology transfer together under the umbrella of a formal organization with constrained powers over each university. Our conceptual approach thus blends theoretical perspectives by acknowledging macroinstitutions (like Bayh–Dole) that guide
cognitions and behavior, while at the same time focusing on the individuals iteratively reacting to and shaping institutions, reconciling the macroworld of formal institutions with the microworld of human agency and practice (Kaghan and Lounsbury 2011; Lawrence, Suddaby, and Leca 2011). We thus use the perspective of institutional theory to contest the idea that individuals respond to institutional pressures in predictable ways.

We base our analysis on a series of semi-structured interviews with twenty-two key informants drawn from TULCO’s board and staff members, university faculty and staff who either worked with TULCO or on research commercialization during TULCO’s existence, and outside observers (including attorneys who worked with university staff and local economic developers). We augment these perspectives with archival materials including TULCO annual reports, board meeting minutes, correspondence between the universities and the organization, and press coverage from the period. We show how officials from each of the three campuses separately and continually interpreted the collaborative’s value against their own institution’s long-standing traditions, missions, and attitudes toward industry engagement and licensing. Over time, each of the three universities came to embrace different understandings of TULCO’s usefulness—leading the three universities to drift away from one another and, over a period of time, leave TULCO. Still, despite TULCO’s early demise, we argue that the organization proved an efficient means for each university to catch up on commercialization outcomes—and that the collaboration was critical for jump-starting regional technology development and furthering the Research Triangle region’s status as a recognized leader in university-led regional development.

Institutional interpretation, as an extension of the concept of institutional logics, is developed in the next section after a brief discussion of technology transfer and Bayh–Dole. The second and third sections discuss the case and explore how institutional interpretation can add to our understanding of why the three universities drifted apart. In the final section, we demonstrate that while TULCO reflects a unique moment of promise in the early post-Bayh–Dole years, its lessons are increasingly prescient and offer considerations important for interuniversity collaborations. We draw three of these. First, universities must go beyond recognizing shared goals to interrogate and address fundamental differences in preparations, motivations and power relationships. Second, collaborations must allocate access to distinct resource streams in a mutually beneficial manner. Third, collaborations need established performance metrics, equitable and transparent procedures, and opportunities for functional exit for when universities need to withdraw and re-center on unique institutional needs.

Adapting to the Bayh–Dole Mandate: Literature Review

The 1980 passage of Bayh–Dole formalized the responsibility of universities to advance the commercial potential of federally funded research discoveries. While often presented as a discontinuity in the history of research commercialization,
Bayh–Dole legitimized efforts by select universities to take an active role in patenting laboratory discoveries, owning intellectual property and securing licensing revenues (Sampat, Mowery, and Ziedonis 2003; Colyvas and Powell 2006). At the time of its passage, only twenty-five universities had established technology transfer offices (TTOs; Mowery et al. 2001); by 1995, about 80 percent of American research universities had established TTOs to facilitate these activities (Association of University Technology Managers [AUTM] 2015). However, a subset of universities, reflecting older norms of scientific discovery that stressed distance from industry, delayed the formation of TTOs—often for years after Bayh–Dole (Feldman and Desrochers 2003).

For these universities, the intervening years from 1980 to 1995 were a time of negotiating changing university culture toward being an entrepreneurial university and building the new institutions to support technology transfer. While the national legal mandate required the creation of new campus organizations, uncertainty in the early post-Bayh–Dole years meant it was not always obvious how universities should change both their cultures and organizational structure nor what incentives or policies were required to engage faculty and encourage work with industrial partners (Feldman, Colaianni, and Liu 2007). Nor was the era’s changing nature of TTO structures and policies unique (Bradley, Hayter, and Link 2013). Indeed, Eisenberg and Cook-Deegan (2018) document the ways in which university technology transfer continues to be co-opted from its original intention of increasing innovation to a focus on revenue generation for universities.

Research universities are essential but not sufficient components of regional ecosystems. Their ability to contribute and lead regional development depends both on characteristics of the external environment as well as internal operations and incentives at the institution itself (Bercovitz and Feldman 2006; Hayter et al. 2018; Malecki 2018). Bozeman, Rimes, and Youtie (2015) review the extensive literature on technology transfer, highlighting the importance of process reforms and the need for attention to create public value. While this core process of establishing a TTO has been frequently undocumented and opaque, Horner et al. (2019) highlight the importance of managerial and strategic choices in explaining observed heterogeneity in technology transfer and regional economic impacts. For university TTOs in particular, there was a need to define an internal identity in order to be perceived as legitimate to both internal and external stakeholders (O’Kane et al. 2015)—a process that is more complex in an interorganizational collaboration among diverse universities.

The creation of complex interorganizational collaborations has been studied before (Perrow 1986). As an illustrative example, Philip Selznick examined the Tennessee Valley Authority (TVA; Selznick 1953). TVA was meant to create economic development in an underdeveloped region in the middle of the Great Depression by producing power, manufacturing fertilizer, controlling flooding, and increasing the utility of waterways by building ports, widening channels, and building dams. Selznick documents the ways in which the goals of the TVA were
subverted as powerful local and national interests—including the US Department of Agriculture, the Farm Bureau Federation, local land grant colleges and universities, agricultural extension workers, and local business and political leaders—sought to control the agenda and co-opt the program. As a consequence, TVA did not fully achieve its objectives and was forced to adjust to a shifting external environment. Selznick highlights tensions between the rational, means-oriented process of administration that is guided by a search for efficiency, and the value-laden adaptive response required by the processes of building an organization responsive to multifaceted objectives and power relationships. Creating institutions is thus a process of organic growth, wherein the organization adapts to the strivings of internal groups in the context of the values of the external society (Perrow 1986, 167).

To the extent that a collaborative TTO is a unifying project between universities set on knowledge generation and governance, universities should be well-positioned to individually and collectively benefit from the existence of the collaboration (Christopherson 2002; Asheim and Coenen 2006). Yet the literature has challenged the premise that a centralized TTO, as would be required for such a project, controls a highly linear “pipeline” of technology development and commercialization (Bradley, Hayter, and Link 2013). Siegel and Wright (2015) argue that academic entrepreneurship in particular has been pushed not only by TTOs but by institutionally unique constellations of actors. Offices and departments across the university each have their own sets of interests in encouraging commercialization, with goals and objectives that could overlap or conflict. Business schools might push for academic entrepreneurship as a way to merge scientific research with a “hands-on” model of teaching, development offices might see university licensing as a means to appeal to donors, and admissions offices may view social entrepreneurship as a way to recruit undergraduates; each of these offices may in turn support programs and policies that shift or redirect the funding and marketing of technology. Donegan and Lowe (2020) present a case of one such example, where a business school’s intent on expanding entrepreneurship-based teaching and programming was a driving force in the creation of broader on-campus research commercialization programming (see also Donegan 2019). While the TTO remains important in this way of thinking, it is just one of many nodes across campus (Hayter et al. 2018).

Relaxing the early literature’s assumption of a powerful, centralized TTO and instead allowing for multiple corners of commercialization policy-making across the university opens the door for campus-specific constellations of power, policies, and norms—which might ultimately undermine the efficacy of a joint collaboration. These campus-specific constellations can be thought of as institutional logics or “the socially constructed, historical patterns of material practices, assumptions, values, beliefs, and rules by which individuals produce and reproduce their material subsistence, organize time and space, and provide meaning to their social reality” (Thornton and Ocasio 1999, 804). Institutional logics acknowledge that actors have agency in their everyday lives but assume that they are constrained within the socially and culturally constructed bounds of the prevailing institutional logic.
Within an organization, institutional logics can manifest as formal, written policies—or informal, “taken-for-granted” rules and norms of behavior (DiMaggio 1988; Beckert 1999). In practice, institutional logics assist actors in focusing on a narrow set of issues to address, developing a set of acceptable potential solutions, and identifying legitimate longer-term organizational goals to pursue (Thornton 2002).

Yet institutional logics within organizations are not static. Periods of heightened uncertainty—such as the early post-Bayh–Dole years—expand opportunities for institutional entrepreneurs to act with “strategic agency” to either challenge or break existing institutional logics (DiMaggio 1988; Beckert 1999). Stovel and Savage (2006), for example, detail how organizational tensions arising from a series of mergers at London’s Lloyds Bank exposed incompatibility in the institutional logics of employment relations at the newly created national bank—resulting in the emergence of new institutional logics governing modern, geographically mobile banking careers. Greenwood and Suddaby (2006) examine changes in the Canadian business services industry and find that actors coming into contact with different logics at outside organizations are more likely to drive change in periods of uncertainty. In these and other cases, the meeting of competing logics via organizational change necessitates that actors within organizations recognize and grapple with preexisting logics—and make decisions about future logics (Thornton and Ocasio 2008).

As with the cases of merged banks and expanding business services, organizational changes within universities in the post-Bayh–Dole years may have brought multiple, distinct institutional logics into contact. These can be thought of as competing institutional logics. Building on the concept of competing logics, Lowe and Feldman (2017) focus on what they call gaps in institutional logics. They point out that actors subject to competing logics often identify distinct differences in the rules, norms, practices, and so forth that exist between the competing logics; these are gaps between the logics. For example, if according to one logic, staff members interpret technology commercialization as outside the purview of universities and thus respond to disclosed inventions by directing faculty to an off-campus attorney, but a new, competing logic suggests the university itself should be involved in the patenting process, there will be a gap between two distinct logics—in this case, between an older, campus-based informal logic and the newer, formal Bayh–Dole logic. When confronted with these gaps, actors (in this example, university staff) then actively try to make sense of competing logics through a series of experiential and experimental decisions.

It is through recognizing gaps in institutional logics that institutions become a “lived experience.” Lowe and Feldman call this process institutional interpretation. As they write,

Rather than simply acting out a universal institutional script, economic agents interpret and reinterpret their institutional settings in ways that reflect and reinforce differences in interpretation. This implies that institutions can simultaneously coexist in multiple...
idiosyncratic states, reflecting a variety of interpretative frameworks through which economic actors engage with, and make sense of, their institutional surrounding. (p. 3)

While interpretation can occur as an “individual cognitive process” (Weick 1995), Lowe and Feldman note that actors and thus interpretation is socially situated, reflecting “larger historical and social context[s],” where an activity like “making sense of institutions is primed by social cues and edited through social feedback,” drawing on Weber and Glynn (2006). The result is that “institutional frameworks are interpretative and shifting,” both over time but also between institutional contexts (Lowe and Feldman 2017, 3; see also Lester and Piore 2004). To illustrate, they use the example of regional firm financing practices. While the region they study is characterized as being “underdeveloped and weakly capitalized” (p. 5), they suggest that a reliance on well-defined and formal metrics misses rich, local organizational heterogeneity in funding development that has emerged through institutional interpretation. The region is home to few traditional venture capital firms but also a growing community of investors that embrace sustainability and diversity goals. This led to iterative experimentation around funding and new search and syndication strategies. Ultimately, a different interpretation of entrepreneurial finance led to a different logic in the region.

Noteworthy in this approach is that actors do not necessarily act with strategic agency to further their own self-interest. Rather, actors focusing on gaps experience a “productive friction” (Stark 2011) as they test out new ways of thinking about, processing, visioning, working, and collaborating under competing logics. Nor does a single, new “winning” logic necessarily emerge from the interpretive process. Conceptualizing competing logics—and the focus actors have on the gaps between these logics—as a process of institutional interpretation allows multiple logics to coexist in states of flux, without necessarily leading to conflict or discord, for long periods of time. Implicit in this conceptualization is that institutional change can be slow-moving. Actors’ decisions can be small with corresponding institutional changes unobservable over a short period of time. This is especially true if individual organizations associated with competing logics create a space for actors to test out or nurture new forms of logic. But over a longer period of time, seemingly inconsequential decisions or actions can lead to profound changes in institutional logics.

Returning to university technology transfer, gaps (or differences) in institutional logics could have existed between each university’s prevailing logic and the emerging national logic of Bayh–Dole and could also have existed between each university brought into an intrauniversity collaboration. Outside the select set of elite universities with TTOs in the 1980s, university research commercialization was governed by informal campus institutions—values and beliefs about commercialization, but also makeshift practices to transition technologies off of campus through a variety of campus offices (Mowery et al. 2001; Breznitz 2014). For universities in the post-Bayh–Dole era, while higher-level administrative responses to the changing national technology transfer logic were aligned with strategic visions for the university (Oliver 1991; Eisenberg and Cook-Deegan 2018), the everyday decision-
making within each university’s long-standing institutional logic might also reflect
views of scientists and university staff. These actors, who had engaged with their
university’s unique prevailing logic, each had opportunity to reconcile gaps between
the new, formal institutional logic of Bayh–Dole, their own older informal campus-
specific logics, and the corresponding logic of partner universities in innovative,
creative, and interpretive ways. Even if each university agrees that a collaborative
TTO is a mutually beneficial way to catch up to elite national peers, over time,
differences in gaps may cause universities to evolve away from each other and
reconsider the usefulness of such a shared project. Moreover, those differences will
be more pronounced as the macroenvironment changes—that is, as universities
across the country came to rely on Bayh–Dole not as a social good but moneymaker
(Eisenberg and Cook-Deegan 2018). We argue that how those differences mani-
fested ultimately undermined foundations of the shared project.

**Methodology/Data**

Our methodology relies on data drawn from published reports and archival docu-
ments, interviews with key informants, and AUTM. Archival data are drawn from
twenty-nine primary documents, including six TULCO annual reports, nine sets of
TULCO meeting minutes, and miscellaneous memoranda, letters, proposals, studies
and contracts. The Appendix includes a list of all of the documents and their sources.
They are also available from the authors upon request.

We directly draw on a series of semi-structured interviews with twenty-two key
informants to complement our archival data. Perspectives from these interviews
provide information unavailable from documents, highlighting differences in cul-
ture, research functions, flexibility, and expectations of TULCO at each of the
universities in addition to the constraints faced by the licensing staff. These
twenty-two include eight individuals who worked for the licensing consortium in
various capacities, three university representatives who worked directly with the
consortium during its initial operations, two former board members at either TULCO
or its major funder (the Triangle Universities Center for Advanced Studies, Inc.),
seven faculty members who worked either with the consortium or university tech-
nology offices as inventors during TULCO’s time (including one who also worked
with a university’s internal patent committee), a local economic development offi-
cial with connections to university-led development, and an outside lawyer who
worked with academic inventors in the 1980s and 1990s. Identities of these indi-
viduals remain confidential. Titles are utilized only when permission was given to do
so, but the small number of surviving individuals from this time requires titles to
occasionally be vague or unlisted. The majority of these interviews lasted between
thirty and ninety minutes; most contacts included an e-mail follow-up to confirm
interview details or quotes. We returned to several interviewees for more than one
full interview; one informant has graciously granted us close to four hours of access,
and we remain in intermittent contact with a number of our sources.
We supplement our interview and archival data with insights from previously published secondary sources—both our own (Lowe and Feldman 2018; Clayton, Feldman, and Lowe 2018; Lowe and Feldman 2017; Feldman and Lowe 2015; Donegan 2019; Donegan and Lowe 2020) and others (Luger and Goldstein 1991; Goldstein and Glaser 2012; Link 1995), including an unpublished dissertation by Dr. Lisa Goble (2013). Finally, we use data from AUTM (2015), which started collecting data on university technology transfer in 1991 and annually thereafter.1

This work is part of a broader case study we and others in a larger research group have pursued for over a decade (see Feldman and Lowe [2015] for a discussion of the case). We rely on the extended case method, which is ideal for reconstructing or elaborating on theory as well as for seeking out the connectedness of practices, policies, cultures, and organizational forms. This makes it particularly well-suited for studies that examine institutional logics. As Wadham and Warren (2014) write,

to the extended case method, context is everything: the organization or community is not an arena where such patterns are played out, but a constellation of specific individuals and relationships located in time and space who respond to, resist, and thereby ultimately influence those patterns. (p. 9)

The extended case method begins with basic theory but continually uses data in real time to interrogate and iteratively update that theory (Burawoy 1998). The extended case method does not typically rely on formal code books for coding source material. For this study, we transcribed or created detailed summaries (with key quotations) for our early interviews and reviewed them with early sets of codes to identify inconsistencies with initial theory. We then resolved these inconsistencies through subsequent interviews or readings of archival materials, in doing so rebuilding or refining theory. The process is thus iterative, with each wave of interviews and readings resolving some inconsistencies while revealing still others (though less so over time). This is also in part why our data were helped by our ability to return to sources for follow-up e-mails or conversations over multiple years.

We believe the result is a rich understanding of the case. Over the past decade, we have together interviewed or held focus groups with over fifty additional informants in the region, including academic inventors and entrepreneurs from these universities, economic development officials in the Research Triangle area, officials from these and other local universities, attorneys who work with university faculty, outside researchers at leading local industry (e.g., GSK, Pfizer), state and local elected and appointed officials, and so forth. We do not consider these sources to be key informants for the purposes of this article. Still, the tenure of many of these individuals overlapped with TULCO; we have used their memories and opinions of research commercialization efforts and how the universities operated in relation to each other to triangulate and confirm data from archival and key informant sources.
Study Context

The three universities in the Research Triangle region have unique characteristics that are important to understanding their motivations and participation in TULCO. While now a top-ranked, nationally recognized research university, at the time of TULCO’s formation, Duke was a well-known regional, private research university with strong research and commercial activities at their medical school and significant industry partnerships in their engineering school. NCSU was and is a land grant university with an emphasis on agricultural and veterinary sciences; its engineering program has a long history of industry engagement (e.g., textiles, agriculture). UNC was and is a prestigious public flagship research university, with a strong college of arts and sciences and a medical school with a public service orientation.

The three universities had (and continue to have) a tradition of local collaboration. For example, the oldest academic library consortium in the United States, the Triangle Research Libraries Network, has roots back to the 1930s. The Research Triangle Park initiative began in 1958 to bring together the three universities to promote industrial development. Collaborative efforts continued when in 1975 the Triangle Universities Center for Advanced Studies, Inc. (TUCASI), a nonprofit corporation, was founded on a 120-acre tract within the Park. Given one of the last large tracts of land in the Park, TUCASI was created to ensure the continued, collaborative commitment of the three universities to the Research Triangle Park. The site eventually housed other collaborative organizations including the Microelectronics Center for North Carolina, the North Carolina Biotechnology Center, and the National Institute of Statistical Sciences (Link and Scott 2003).

Commercialization at Duke, NCSU, and UNC

Despite strong research profiles at each university, all three universities lagged in commercialization at the time of Bayh–Dole’s passage. In 1983, UNC System President William Friday created a technology transfer committee to evaluate existing efforts on the system’s sixteen campuses (Goble 2013). In 1984, the committee hired consulting group Cambridge Associates, Inc., to develop recommendations for improving system-wide technology transfer. The resulting 1985 report argued that system efforts should focus solely on NCSU and UNC—the campuses conducting research with the most commercialization promise. The need for a renewed push for technology transfer on both campuses was pressing; by the time of the report’s release, NCSU and UNC each had a staff member devoting just half of their time to technology transfer. Goble (2013) argues this left both campuses understaffed, and that NCSU and UNC’s mid-1980s research funding (ranging from $54 to 75 million) required a full-time employee on each campus (Clough 1985). Low staffing levels meant existing staff could only manage the legal aspects of transferring technology and not the marketing or relationship-building tasks deemed critical to research commercialization.
While the report considered improving technology transfer at NCSU and UNC separately, Cambridge Associates ultimately recommended an interuniversity technology transfer collaboration. Resulting pooled resources would allow personnel to specialize in specific aspects of the licensing process and on particular industries, in turn allowing workers to “focus efforts and build credibility with faculty and industry experts. This would lead to more effective marketing of inventions, efficient use of resources, and development of economies of scale in technology licensing activities” (Goble 2013, 89; see also Clough 1985). Cambridge Associates also recommended that Duke become a member of any regional consortium. This recommendation was, again, in large part about resources—specifically, personnel specialization—that Duke’s inclusion would afford. Like NCSU, Duke had an intermittent technology transfer presence before TULCO. While Duke’s office was not fully functional at the time of the report’s release, past offices had a full-time staff member. Beyond the resources Duke could bring, Cambridge also noted that Duke’s presence would allow for a united triangle in marketing developed technology (Goble 2013; Clough 1985). At the time, the Triangle was well regarded for its science park, but there were questions about the potential of the start-up firms to spin out of the universities and prosper (Luger and Goldstein 1991; Markusen 1996; TUCASI Board Member A, August 6, 2008).

Critically, Duke’s presence would also allow for a new, separate source of funding via TUCASI. In 1974, the president of the Research Triangle Park Foundation directed Duke President Terry Sanford and UNC President William Friday to develop a plan to ensure all three of the region’s research-intensive universities remain involved in the Research Triangle Park. To that end, the foundation donated 120 acres of land in the Park to be used by “organizations that could bring together faculty from the three universities and Park scientists to work collaboratively” (Link and Scott 2003, 169). TUCASI emerged as one of these organizations, becoming a “park within a park” for the three universities—and an entity with funding available for efforts that involved Duke, NCSU, and UNC (Link 1995).

Cambridge Associates recommended that each university commit to a consortium for five to ten years. As system universities, NCSU and UNC immediately committed. But “Duke came to the table . . . fairly [reticently] . . . certainly [when] compared to the other two” (TTO Staff Member, February 18, 2016). While Duke, NCSU, and UNC all lagged national peers and lacked the personnel and knowledge necessary for technology transfer, there was considerable heterogeneity in industry engagement traditions, campus attitudes toward technology transfer, and financial resources.

UNC was perhaps the university most in need of a collaboration to drive on-campus research commercialization. Their need went beyond resources. Current staff at UNC look back at the early years after Bayh–Dole as a time when the university,

just didn’t do anything . . . [and] kind of sat around . . . . There were technologies that were developed that probably could have been patented and commercialized and would have been a big deal, but we just weren’t wired that way. (UNC Staff Member A, March 1, 2016)
This wasn’t due to underdeveloped research capabilities; the university “garnered a lot of sponsored research dollars, but none of it was transferred to commercial entities” (UNC Staff Member B, June 22, 2016). Yet faculty at UNC remained “hostile” to commercialization (UNC Staff Member C, January 26, 2016) well into the 1980s, thanks in part to the prevailing idea/culture that faculty at non–land grant, public universities like UNC “were not necessarily encouraged or allowed to do a lot of consulting” (TTO Staff Member, February 18, 2016) with industry (see also Goldstein and Glaser 2012; Donegan and Lowe 2020; Donegan 2019). This was recognized during TULCO’s planning, too; Stuart Bondurant, dean of UNC’s medical school, noted in a technology transfer committee meeting in 1985 that “the culture of technology transfer of the University of North Carolina was not as developed as at some other institutions” (Heath, February 20, 1985).

Like UNC, NCSU’s low TTO staffing levels reflected what Goble (2013) refers to as the “nascent entrepreneurial culture and limited infrastructure supporting technology commercialization” (p. 87). While both had formal policies in place to govern disclosure and patenting, neither had set up systems for faculty incentives. Yet, in contrast to UNC, NCSU had long considered the functions of technology transfer and industry engagement to be part of their mission as a land grant university (Meszaros 2004). Although both NCSU and UNC had half-time employees working in technology transfer by the time the consulting report was released in 1985, NCSU had begun to patent campus technology in the 1970s. As a former TTO staff member notes, “[NCSU] was doing translational research before anybody even knew what that term meant” and was “more emboldened [and] more culturally comfortable moving into the applied arena and technology development” (TTO Staff Member, February 18, 2016).

Duke had more faculty members consulting or engaging with companies when compared to UNC, and as an institution was “very interested in working with pharmaceutical companies, particularly with medical device and imaging companies” (TTO Staff Member, February 18, 2016). Christopher Fordham III, UNC chancellor during TULCO’s planning, noted in a 1985 letter to TUCASI President (and UNC chemistry professor) William Little that “the existing program at Duke is more sophisticated” than those at UNC and NCSU (Fordham). Yet, while NCSU’s industry engagement was tied to its land grant mission, some part of Duke’s desire to engage with industry was driven by the university’s perceived need for funding. As a former staff member said, “they needed more private support [because they weren’t a public university],” and they were “driven by the desire to extract or to secure corporate research funding” (TTO Staff Member, February 18, 2016). In a letter to Duke President Keith Brodie in 1986, Duke Vice President and General Counsel E. J. McDonald noted that in addition to meeting the objective of “improved professionalism and expertise in the commercialization and licensing of inventions brought forward by the Duke faculty,” the consortium would offer “relief for the general fund” (McDonald), thanks to both lower costs and expected increased licensing revenues. Duke, as a private university, did not receive the high levels of state
funding that NCSU and UNC did during the 1980s, and the university faced pressures in faculty and student recruitment (Donegan 2019). A former TTO staff member ultimately suggests that the promised money from TUCASI and associated general fund relief was in fact the primary reason Duke joined:

at the end of the day, the fact that TULCO involved all three [and] . . . secured five years of funding . . . That was alone enough reason for Duke to say “hey . . . rather than staff up here, let’s just sign on and be a participant in this TULCO enterprise, and see how it evolves.” (TTO Staff Member, February 18, 2016)

With all three universities on board, TUCASI agreed to fund a consortium at a rate of $360,000 per year for a period of five years; funding after that initial period would be at a lower rate and determined at a later date. TULCO also gained access to free space at the Research Triangle Institute (RTI, now RTI International, an independent nonprofit research institute), with the understanding that TULCO would handle any licensing needs that RTI had.

Nevertheless Goble (2013) argues that TULCO was conceived of with a fairly narrow mission, being “formed solely to provide technology licensing services for each of the three universities, enhance their existing internal capacity, and realize significant efficiencies and cost savings” (p. 92). Numerous documents from TULCO’S planning stages reveal worries about the organization gaining too much power. Raymond Dawson, vice president for academic affairs and senior vice president of the sixteen-campus UNC system, noted that “many similar entities established within or by [UNC] had evolved into autonomous organizations rather than functioning as agents of the institutions that had created them” (Heath, October 9, 1985). Christopher Fordham III writes to reassure William Little that TULCO had been structured in such a way as “to avoid the possibility of developing a ‘life of its own’, independent of the wishes of its parent universities” (Fordham 1985). For their part, representatives from both NCSU and Duke expressed a desire to retain pre-existing contacts with industry; for example, Ralph McCaughan, counsel from Duke, stressed Duke’s desire “to continue the existing relationships that it had established with corporations and be free to initiate additional corporate relationships in the future” (Heath, October 9, 1985).

TULCO opened for business in January 1988 with a staff of eight—far more than the combined personnel had been at Duke, NCSU, and UNC. Goble (2013) reports that following the conclusion of its first year, “the universities were unanimous in acknowledging [that] TULCO’s capabilities and resources had [increased] licensing inventions from their campuses, and had helped to expand the reach of industrial interactions,” and that its ability “to engage with this level and array of expertise in technology transfer functions on a campus-by-campus basis would not have been possible without the creation of the consortium” (p. 95). Data from the TULCO annual reports (see Table 1) also show an improvement in a number of indicators.
Positive responses were similar after the second year, but not after the third. Goble points to the departure of key personnel—including TULCO’s campus liaison for Duke—as placing a strain on the organization. A lack of space for TULCO at RTI was also a problem as was the flat funding from TUCASI; licensing from all three campuses had increased, but resources had not. Additionally, by the end of TULCO’s third full year (1990), “institutional, cultural, and organizational differences [had] surfaced,” as had “differing expectations among the three universities” (Goble 2013, 96).

The main driver of these differences appears rooted in how each university viewed and used TULCO’s resources—and how they correspondingly built up resources on campus. Given TULCO’s designed, limited mission, planning documents for TULCO stressed “that each university will continue... operating an internal administrative technology transfer office on its campus...” (Ehringhaus, 1986). Yet UNC had retained only a small on-campus office to handle technology transfer within its Office of Research Services and therefore “made very aggressive use of TULCO” (TTO Staff Member, February 18, 2016). TULCO acted as “essentially the invention triage and assessment mechanism that UNC had.” UNC made no efforts to ramp up its own internal capabilities;

by virtue of almost completely outsourcing the [licensing] function, [UNC] maintained a great deal of interest, support, and willingness to have TULCO... present its technology licensing opportunities to the rest of the world. (TTO Staff Member, February 18, 2016)

<table>
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<tr>
<th>Fiscal Year</th>
<th>Invention Disclosures</th>
<th>CDA Initiated</th>
<th>CDA Finalized</th>
<th>Licenses Initiated</th>
<th>Licenses Finalized</th>
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<tr>
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<td>142</td>
<td>112</td>
<td>88</td>
<td>84</td>
<td>41</td>
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<td>40</td>
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<td>1992d</td>
<td>146</td>
<td>107</td>
<td>88</td>
<td>63</td>
<td>34</td>
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<td>97</td>
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<td>1994</td>
<td>131</td>
<td>132</td>
<td>115</td>
<td>42</td>
<td>35</td>
<td>255</td>
<td>117</td>
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<td>1995a</td>
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<td>30</td>
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<td>909</td>
<td>793</td>
<td>626</td>
<td>420</td>
<td>256</td>
<td>572</td>
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</table>

Source: Compiled by Goble (2013) from Triangle University Licensing Consortium Annual Reports.

aConfidential Disclosure Agreements.
bThese numbers are total for all three triangle universities and are those patents issued from the patent application filings in each year of TULCO’s operations.
cSix months of official operations, activities started with the hiring of an executive director in 1987.
eData are only available for three months (1st quarter) of the 1995 fiscal year.
UNC’s lack of effort to handle commercialization work in house is reflected in their disproportionate use of the consortium’s resources. Between 1988 and 1994, UNC accounted for 47 percent of disclosures sent to TULCO.

NCSU treated TULCO as a “specialized consultant” to be turned to “strategically” by their patent attorney—an individual they had hired from MIT (one of the leading early movers in technology transfer). Thus “NCSU had a more sophisticated approach to how to use TULCO and really leverage what their very experienced sole practitioner... could do on her own” (TTO Staff Member, February 18, 2016). Still, NCSU’s “struggles to meet the growing technology licensing and commercialization needs for their expanding research and industry research partnerships” (Goble 2013, 99) reflected TULCO’s inability to keep pace with rapidly increasing levels of licensing and NCSU’s small on-campus TTO. Duke used TULCO to “ramp up [the internal officer’s] learning curve and experience base” and “to build up internal capacity” (TTO Staff Member, February 18, 2016). At the time it joined TULCO, Duke had no active TTO but soon instituted a search for a full-time technology transfer director. Like NCSU, that director used TULCO as a specialized service and over time was able to pull more work in-house.

As the original five-year grant was expiring, TUCASI made the decision to renew the grant at half of what had been paid previously. Upon learning of the lowered funding, Duke decided to cease its full membership in TULCO (though it would continue to separately contract with the organization through 1995). Part of Duke’s motivation reflected a strategic decision about the university’s resources; a former Duke staff member recalls the thinking as being, “if we’re going to invest... quite a few hundred thousand dollars in TULCO, we’ll invest that [in Duke] and continue to build our institutional capacity” (TTO Staff Member, February 18, 2016). But Duke also felt like it was “not receiving a fair share of the services provided by TULCO’s operations,” thanks to UNC’s outsized use of the service (Goble 2013, 107). At the time of Duke’s 1993 departure, The Triangle Business Journal reported 1992 licensing revenues as $1.1 million at NCSU, $450,000 at UNC, and $500,000 at Duke. In that same piece, Duke’s Office of Science and Technology director Robert Taber is quoted as saying, “by going on our own we hope to do better. The purpose of [Duke’s departure] is to increase our licensing activities” (Mukherjee 1993, 1).

An examination of AUTM data at this time shows why Duke may have expected licensing revenue to be more similar to NCSU than UNC (see Table 2). Heterogeneity among the three universities can be seen in data. For example, while Duke and UNC in particular both had large research expenditures, UNC’s industry-sponsored research was consistently lower than Duke’s and NCSU’s. And UNC had consistently fewer active licenses. Assuming that 1992 active licenses were similar to those active in 1991 and 1993, Duke’s extraordinarily large number of active licenses (140 in 1993) relative to UNC’s (56 in 1991 and 107 in 1995) generated less income in 1992.

Duke’s departure left NCSU and UNC paying for a substantial portion of TULCO’s operations. NCSU, which had also felt that they were not receiving their “fair
### Table 2. Association of University Technology Managers’ Data.

<table>
<thead>
<tr>
<th>Institution</th>
<th>Year</th>
<th>Total Research Expenditures (in Millions)</th>
<th>Federal Research Expenditures (in Millions)</th>
<th>Industry Research Expenditures (in Millions)</th>
<th>Licenses Issued</th>
<th>Invention Reports</th>
<th>Active Licenses</th>
<th>Gross Licensing Income (in Thousands)</th>
<th>Total Patent Applications Filed</th>
<th>Start-ups Formed</th>
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<td>$35</td>
<td>140</td>
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<td></td>
<td>$641</td>
<td>139</td>
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<td>$377</td>
<td>$86</td>
<td>22</td>
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<td>56</td>
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<td>550</td>
<td>$2,598</td>
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Note: NCSU = North Carolina State University; UNC = University of North Carolina at Chapel Hill.
share” at TULCO, “pretty rapidly began making plans to staff up and build its own capacity” after Duke’s departure (TTO Staff Member, February 18, 2016). UNC, however, did not. It wasn’t until NCSU left the consortium in 1995—and TULCO ceased to exist—that UNC formally built out their TTO. Even then,

UNC was still sort of coming to grips with what it meant to be in the tech transfer business, but it did begin expanding their capacity, for them relatively quickly. It was still, at a critical mass level and overall capacity level, it was smaller than either of the other two...[and] I think that it reflects sort of the interest. (TTO Staff Member, February 18, 2016)

Negotiating Uncertainty at Duke, NCSU, and UNC

TULCO embodies the idea that a regional, centralized, organizing body can coordinate and kick-start regional technology transfer efforts and improve universities’ contributions to a regional economy. Implicit in TULCO’s mission is the idea that a centralized TTO could supersede existing research commercialization structures at each university. Given each university’s underdeveloped organizational structures in the mid-1980s, the idea that a well-funded and staffed organization could build a region-wide system is not untenable. The assumed ease likely also reflected TULCO’s framing as an extension of a successful tradition of collaboration, one where “the disparate opinions and desires of many groups [including] the universities...had been reconciled for the common good of the state” (Link 1995, 93).

But the assumed ease of TULCO’s task ignored each university’s ingrained informal institutional logic of technology transfer. Nor did TULCO’s creators recognize that gaps between the formal and informal institutional logics of technology transfer varied considerably between campuses. TULCO, with a strong formal institutional logic linked to Bayh–Dole, had to somehow envelop disparate existing campus institutional logics with a structure that, as Stuart Bondurant noted in a technology transfer committee meeting, “would somehow have to combine elements of centralization and decentralization in order to be effective” (Heath, February 20, 1985).

Officials at each university—when faced with competing logics between TULCO and their own campus’s embedded, informal institutional logics—reconciled them through institutional interpretation. NCSU and Duke, with strong traditions of industry engagement, were not averse to licensing. Still, differences in preexisting institutional logics contributed to different interpretations of Bayh–Dole by these two and, by extension, TULCO. For its part, as a public land grant university, “[NCSU] was always...more committed than the other two to industry engagement and technology transfer” (TTO Staff Member, February 18, 2016), having been an “early pioneer of industrial extension service” (Tornatzky, Waugaman, and Gray 1999, 44). NCSU had been intermittently licensing to industry for a decade before TULCO
opened. But TULCO allowed NCSU to envision a new form of its land grant industry engagement heritage. In 1984, when the technology transfer committee asked Cambridge Associates to develop a technology transfer plan, NCSU received a “second land grant” next to its campus in downtown Raleigh (Meszaros 2004). Planning for NCSU’s Centennial Campus—a 780-acre downtown “technopolis” where “university, corporations, and government agencies worked together” began in 1986. In order to lease space on Centennial Campus a prospective tenant must have some programmatic connection to NCSU. While Centennial Campus now has a strong academic entrepreneurship presence, in the 1980s, firms licensing NCSU technology were key tenants. NCSU envisioned TULCO as a way to commercialize university research and transfer it to a proximate, physical landing pad—assisting state industry, as had long been its mission. NCSU interpreted the space between Bayh–Dole and its land grant history of industry engagement as a way to not just further its licensing activities but to actively embed those activities on campus; TULCO provided financial resources through NCSU’s increased licensing, and as a specialized consultant was a useful source of information. Together, TULCO and this new land grant allowed the university to “redefine what it [meant] to be a land grant university in the knowledge economy” via the Centennial Campus (Tornatzky, Waugaman, and Gray 1999, 44).

In contrast, Duke, as a private institution, had no formal responsibility to contribute to the economy or general well-being of the state of North Carolina. Instead, Duke was trying to move up in national academic rankings. As other peer institutions were ahead in technology commercialization, prospective faculty were beginning to ask Duke about policies and revenue distribution (Bercovitz and Feldman 2008)—drawing attention to a need to become more professional in technology commercialization. Additionally, Donegan (2019) explains how Duke’s commercialization strategy was heavily tilted toward licensing to larger corporations to fuel the university’s redevelopment of adjacent residential and commercial areas and, eventually, the ailing downtown Durham (see also Keohane 2006). Duke, when faced with competing institutional logics of technology transfer, interpreted technology transfer as a revenue generator. Duke created a new logic that placed their own licensing offices and relationships with large companies front and center. Leaving TULCO and pursuing technology transfer alone provided Duke with an effective means to increase revenue to eventually fund outside projects and the larger university’s budget (Eisenberg and Cook-Deegan 2018).

UNC continued to interpret its non–land grant public university mission as one that should be “reticent to, quote, let industry on the campus, unquote” (TTO Staff Member, February 18, 2016). In the absence of an engineering school and with a medical school that had a strong service mandate, there were few departments on campus ready to actively embrace technology licensing. When faced with competing logics of technology transfer, UNC continued to operate under those conflicting logics. TULCO allowed UNC to put off fully reconciling long-standing norms of research that eschewed commercialization and interaction with industry with Bayh–
Dole’s formal rules of technology transfer. This provided an intermediate step to thread the needle; TULCO, with its off-campus location in RTI, allowed UNC to engage in technology transfer without really needing to “let industry on the campus.” Nonetheless, this time would prove critical for UNC; Colyvas and Powell (2006) argue that the institutionalization of technology transfer required an effort of legitimizing a new way of thinking about science and scientific discovery—and that even at early movers like Stanford University, this transformation took time. TULCO allowed faculty and staff at UNC to experiment, gain experience, and become more comfortable with the ideals and processes of technology licensing. Ultimately, staff from UNC’s business school would interpret technology transfer and research commercialization as a logical educational focus at the school via entrepreneurship—and a new, education and service-centered logic of technology transfer would eventually emerge at UNC (Donegan and Lowe 2020).

Conclusion

In this article, we have drawn on frameworks of competing institutional logics and institutional interpretation to explore how an interuniversity collaboration failed to sustain itself in a region known for cooperative, university-led development. Theoretically, this article makes important contributions to the institutional logics literature by highlighting institutional interpretation as a method through which actors make sense of and negotiate conflicting logics. Our data also allow us to contrast a somewhat rigid, legal institutional logic with loose, informal logics—competing logics that are less common in the literature.

We also believe this article makes important contributions to the research commercialization and regional development literatures by drawing lessons for interuniversity cooperation. At its inception, each of the three universities lagged national peers and benchmarks in terms of sponsored research with industry and technology licensing. Despite the mandate of Bayh–Dole and the potential economies of scale and scope TULCO could provide, large cultural differences existed between member universities. As a result, each university developed different interpretations of TULCO as an institution. While these competing and conflicting interpretations resulted in TULCO’s demise, it’s worth asking: how, if at all, did the organization contribute to the region’s development and in particular to reinforcing the universities as drivers of the local and state economies? Regional leaders certainly had high hopes; in a 1986 letter to TUCASI’s Executive Board, TUCASI president William Little wrote,

...one relatively undeveloped element in the Triangle is this practice of extending innovations from university laboratories to industry, and thus into use by the public .... This concept [is] the single greatest missing ingredient in the Triangle program. That problem and, indeed, opportunity is addressed by this proposal. (Little 1986)
Over twenty years after TULCO’s closure, we identify four contributions TULCO had on both the universities themselves and also, by extension, regional development.

First and perhaps most importantly, TULCO’s existence and efforts were an impetus behind changing campus opinions about commercialization. Campuses were able to rely on TULCO’s off-campus services while the campuses themselves made internal adjustments required to become entrepreneurial universities. At UNC in particular, TULCO allowed the process of commercializing laboratory science to take root in scientific departments—letting some portion of the campus get more comfortable with the idea and setting the stage for the university as a whole to transition during the mid- to late-1990s (Donegan 2019; Donegan and Lowe 2020). While NCSU and Duke had a shorter path in cultural change, TULCO provided resources here, too. TULCO helped NCSU reinvent itself in order to “renew its commitment to North Carolinians” as a new type of land grant (Meszaros 2004), embedding new technologies in the state as it had textiles and agriculture. And while faculty members had a strong tradition of industry consulting at Duke, the push to license technologies fueled Duke’s rise to prestige among private universities.

Second, TULCO played an instrumental role in rapidly scaling up campus commercialization efforts at all three universities. This can clearly be seen in the data in Table 2, which show steady increases in metrics including licensing income, patents, and start-ups. Immediately with the creation of TULCO, combined licensing personnel jumped from three to eight and patent applications at the three universities increased. These resources and successes further legitimized technology transfer and increased faculty participation.

Third, campuses transferred technical and marketing knowledge from the organization to nascent offices on each campus, allowing TULCO’s resources and legacy to linger long after its closure. By using TULCO as a “specialized consultant,” Duke and NCSU were able to informally transfer knowledge from TULCO staff to their own offices when the organization was open. This allowed fledgling TTOs to grow in a supportive, protected setting. When TULCO closed, remaining personnel were absorbed by Duke and NCSU’s TTOs. UNC would eventually benefit from this knowledge too, when a staff member who had been at first Duke and then NCSU’s TTO transitioned to UNC. The career path of this talented individual contributed to future interuniversity collaboration and helped to disseminate technology transfer practices and knit together a regional identity.

Fourth, TULCO played a key part in continuing strong, collaborative interuniversity relationships for the sake of economic and research development—even if in the case of TULCO the collaboration was short-lived—and brought universities into sync with state economic development planning efforts. TULCO built on a decades-long tradition of collaboration—and university officials have remained committed to joint efforts (e.g., 2004’s Renaissance Computing Initiative). In terms of the state economy, TULCO paid special attention to “leveraging existing state resources” like
the North Carolina Biotechnology Center, the Small Business Technology Development Center, and RTI. Moreover, the consortium emphasized licensing to North Carolina companies when possible—a point that was debated throughout the organization’s planning stages and that ultimately became part of the organization’s mission. The Research Triangle region has emerged as a leading center for high-technology companies, especially in biotechnology. The technology and entrepreneurial firms that the region’s universities provide—often in collaboration with one another—has become a backbone of the local industry (Donegan et al. 2019). It is difficult to envision the region’s rise to biotechnology prominence without TULCO.

Still, we can draw several lessons from TULCO’s short tenure that other technology-based collaborations may learn from. First, universities must go beyond recognizing shared goals and interrogate and address fundamental differences in motivations, power relationships, and preparation. For example, while representatives from across the Triangle continually noted that UNC had a lagging culture of commercialization, there was no requirement that UNC take steps to address this in joining TULCO. Similarly, Duke’s focus on revenue and retaining its own contacts stands out—its early departure is not surprising. Second, collaborations must allocate access to distinct resource streams in a mutually beneficial manner. Furthering the UNC example, allowing UNC (during TULCO’s time) to not make necessary on-campus investments in technology transfer—and instead disproportionately rely on TULCO’s shared assets—meant that other universities were not able to access their share of resources. Third, collaborations need established performance metrics, equitable and transparent procedures, and opportunities for functional exit when universities need to withdraw and re-center on unique institutional needs. For example, the push to not allow TULCO as an organization to benefit directly from licensing and instead keep it as an institution unable to develop a “life of its own” (Fordham 1986)—one completely dependent upon infusions of cash from the universities and TUCASI—meant that TULCO’s resiliency was severely hampered. Any withdrawal effectively meant closure for the organization—an unsustainable model.

Research universities continue to pursue partnerships. Like TULCO, many focus on experimental or pioneering technologies, with an eye toward venture creation and regional economic development. The Jacobs Technion-Cornell Institute—a collaboration between New York’s Cornell University and Technion-Israel Institute of Technology—is perhaps the most well-known of these. Located on a sprawling campus in New York City’s Roosevelt Island, the collaboration issues its own master’s degrees while also relying on an experimental, equity-based method of research commercialization (Rivard 2014). Similarly, the New York State Energy Research and Development Authority has fostered two large experimental collaborations through its PowerBridgeNY program; both feature private and public universities and focus on cleantech business creation. Smaller examples exist as well; in North Carolina, UNC and NCSU recently created a joint bioengineering degree program, while in Atlanta, The Georgia Institute of Technology and Emory University created a similar program, The Wallace H. Coulter Department of
Biomedical Engineering. Future research on these centers should examine whether collaborations met their stated goals—including granting degrees, fostering entrepreneurial firms, existing as mutually beneficial endeavors over time—and the extent to which these collaborations took heterogeneous starting points into consideration. But future research must also explore whether and how these collaborations ushered in changes at their parent institutions. TULCO’s lessons and implications with respect to how actors within each university interpreted competing institutional logics and, through doing so, changed their own institutional missions and trajectories, remain salient to today’s ambitious collaborations.

Appendix

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<td>Ehringhaus, Susan H. Minutes from the Triangle Universities Licensing Consortium Meeting Thursday, March 26, 1992.</td>
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### Appendix (continued)

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<th>Document Details</th>
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<td>Ehringhaus, Susan H. Letter from Ehringhouse, Assistant to the UNC-CH Chancellor, to Dr. William F. Little, President of TUCASI, January 15, 1986.</td>
<td>Office of University Counsel, Duke University</td>
</tr>
<tr>
<td>Fordham, Christopher C., III. Letter from Fordham, Chancellor of The University of North Carolina, to William F. Little, President of TUCASI, December 10, 1985.</td>
<td>Office of University Counsel, Duke University</td>
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<tr>
<td>French, Becky R. Minutes from the Triangle Universities Licensing Consortium Meeting Tuesday, June 2, 1992.</td>
<td>Office of University Counsel, Duke University</td>
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<tr>
<td>Heath, Thomas H. Minutes of the Technology Transfer Committee and Others Attending the Meeting on February 20, 1985.</td>
<td>Office of University Counsel, Duke University</td>
</tr>
<tr>
<td>Heath, Thomas H. Minutes of the Eleventh Meeting of the Technology Transfer Committee, October 9, 1985.</td>
<td>Office of University Counsel, Duke University</td>
</tr>
<tr>
<td>Little, William F. Correspondence from TUCASI’s President to Mr. Robert M. Leak, Research Triangle President, Re: Triangle Universities technology transfer and licensing foundation, January 30, 1986.</td>
<td>Office of University Counsel, Duke University</td>
</tr>
<tr>
<td>McDonald, E. J. Memorandum to Duke President H. Keith H. Brodie from Duke Vice President and General Counsel, Re: Joint Technology Transfer Foundation—Duke, UNC-CH, NCSU, January 23, 1986.</td>
<td>Office of University Counsel, Duke University</td>
</tr>
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<td>Proposal to Triangle University Center for Advanced Studies (TUCASI) from Triangle University Licensing Consortium, September 11, 1991.</td>
<td>Courtesy of Dr. Lisa Goble</td>
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<td>Triangle Universities Center for Advanced Studies, Inc: A Brief History (n.d.).</td>
<td>Courtesy of Dr. Lisa Goble</td>
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Note
1. While Triangle University Licensing Consortium (TULCO) began operations in 1988, Association of University Technology Managers’ data are not available before 1991 and Duke did not disclose data until 1993.

References


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